KILAUEA ENERGY PARTNERS

June 8, 1990

VIA FEDERAL EXPRESS

Mr. Manabu Tagomori, Deputy Director
State of Hawaii
Department of Land & Natural Resources
Kalanimoku Building, Room 227
1151 Punchbowl Street
Honolulu, Hawaii 96813

Subject: Hawaii Geothermal Interisland/Transmission Project

Dear Mr. Tagomori:

Thank you for taking the time out of your busy schedule to meet with us during our recent visit to Oahu, and for your comments, thoughts, and suggestions.

We would like to further explore, with you and your staff, the permitting procedures relative to mineral leases, exploration and development drilling permits, Geothermal Resource Subzones and the like.

We would be delighted to arrange a tour of our Aidlin Geothermal Power Generation Facility in the Geysers should you be visiting the mainland any time soon. Please consider this our formal, open-ended invitation.

Your hospitality and candor is most appreciated. We hope to continue our conversations with you in the near future.

Thank you for your consideration.

Sincerely,

Daniel Chase
Mission Power Engineering Company for
Kilauea Energy Partners

REQUEST FOR PROPOSAL

FOR THE

GEOTHERMAL/INTER-ISLAND TRANSMISSION PROJECT

ISSUED BY
HAWAIIAN ELECTRIC COMPANY, INC.
HONOLULU, HAWAII
MAY 1989

4246S

HAWAIIAN ELECTRIC COMPANY, INC.
GEOTHERMAL/INTER-ISLAND TRANSMISSION PROJECT
REQUEST FOR PROPOSAL

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EXECUTIVE SUMMARY

Hawaiian Electric Company, the electric utility that serves the island of Oahu and the city of Honolulu, is interested in purchasing up to 500 megawatts of electricity generated from geothermal resources on the island of Hawaii and transmitted by a combination of overland transmission and submarine cable to Oahu. Hawaiian Electric Company wishes to decrease its dependence on imported oil and strengthen the state's economy. The presence of recoverable geothermal energy on the island of Hawaii has been known for some time. The conversion of geothermal energy to electricity is now a proven, accepted technology. The federal and state research efforts on the Hawaii Deep Water Cable project have resulted in confidence that a submarine cable can be designed, fabricated and installed to transmit electricity from the island of Hawaii to Oahu. Hawaiian Electric Company has a need for power by 1995. The availability of the geothermal conversion and cable technologies and Hawaiian Electric's power requirements have led to this solicitation for power purchase.

This Project is strongly supported by Hawaiian Electric Company and the state government. Hawaiian Electric Company's support for the Project is evidenced by the letter from its President. The Governor of the State of Hawaii has also expressed his interest and support. Letters from these individuals are attached following this Summary.

THE PROJECT

The Project consists of designing, constructing, installing, financing, owning, operating and maintaining an enterprise that will generate electricity from geothermal resources on the island of Hawaii and deliver at the point of interconnection on Oahu up to 500 megawatts (MW) of electricity. Hawaiian Electric Company (HECO) will purchase power on Oahu; it does not seek an ownership or operating interest in the Project. Organizations that have the technical, managerial and financial expertise to develop this Project, or cause it to be developed through others, should respond to this Request for Proposal (RFP).

The intent of the RFP is to solicit commercial interest in this Project. Since HECO will not own the Project, the RFP is a performance related specification. The RFP does request technical information on the proposed design. HECO is not suggesting a price for the Project's power. Proposing organizations should estimate the cost of their Project design and provide a pricing proposal.

Qualified organizations are encouraged to submit Proposals even in that circumstance where it is believed that the acceptability of the offered price for energy is contingent upon actions or assistance by third parties, such as the State of Hawaii.

Hawaiian Electric's present peak load of approximately 1100 MW is anticipated to grow at a moderate growth rate of 2.2 percent/year to about 1600 megawatts in 2005. The HECO system can use 125 MW of baseload power by

1995, more if the power supply is capable of being cycled to more closely match daily load variations, and up to 500 MW in later years. From HECO's perspective, power needs are dependent upon forecasted load growth, unit retirements, installed capacity and, ultimately, HECO's assessment of the reliability of the power generated by the Project and the degree and timing of availability of that power.

THE REQUEST FOR PROPOSAL

The next increment of generation required by the Hawaiian Electric system is about 140 MW in 1995. HECO has to make a decision on this increment by December 1990 to ensure that generation will be available in 1995. Chapter 5 of the RFP discusses the schedule and the need for power in detail.

The power produced by the Project could potentially represent a large portion of the electric power supply for Oahu. To protect the interests of its customers, HECO is very concerned that the Project represent a reliable supply of electric power. The RFP does not specify reliability indices for the Project. However, so that HECO can place confidence in the Project, Chapter 4 requires detailed reliability and availability data which can be independently confirmed and evaluated by HECO.

Careful attention must be paid to design and construction to ensure the reliable operation of the Project. Since the successful PROPOSER will be responsible for the performance of the Project, HECO is not providing design specifications. Chapter 3 of the RFP does identify those technical design considerations and conditions which HECO believes will contribute significantly to a viable Project. It is recognized that only a conceptual design for the Project will exist at the Proposal stage.

Maui Electric Company, Ltd. is interested in determining the technical feasibility of a possible 50 MW tap. Chapter 8 presents data on the Maui system to assist in this determination.

The Project would not be possible without the geothermal resource. While it is believed that the geothermal resources on the island of Hawaii are extensive, not until development is underway and exploration programs are completed is there likely to be a high degree of certainty about the capability of the resource to support the full 500 MW desired from the Project. As a result, it is expected that PROPOSERS will have questions about both the nature and extent of the resource and, as importantly, access to the resource. Included as Appendix A to this RFP is a report, commissioned by HECO, that describes in summary fashion much of the available information about the resource. The PROPOSER is invited to consider that report as well as other information that will be made available by the State of Hawaii in a public document room established for the purpose of facilitating ease of access for potential PROPOSERS to publicly-held information.

This project will be a major undertaking in the state of Hawaii. It is assumed that a variety of impacts will occur, many of which will require the approval of various local, state and federal agencies. Thus, a summary of environmental information is presented in Appendix B to assist in preparing the Proposal. Appendix B also includes a summary of the permits and regulations that likely will affect the Project. The timely acquisition of permits and approvals will be a central consideration in HECO's evaluation of the Proposals.

To facilitate the permitting process, the State of Hawaii has already conducted a very significant number of studies addressing the impacts of geothermal development on the island of Hawaii. As noted in the letter of the Governor of Hawaii, the State has also recently undertaken the drafting of a master plan and a programmatic Environmental Impact Statement for the development of 500 MW of geothermal power on the island of Hawaii.

A Project of this magnitude requires a very carefully written contract for the protection of all parties, including the power customers on Oahu. While a sample power purchase agreement is not presented in the RFP, the major items of concern to HECO are discussed in Chapter 7. Chapter 7 also requests specific information on the economic feasibility of the Project and on the financing plan proposed.

The Project is only as viable as the strength and integrity of the developing organization. Some very specific details of the proposing organization are requested in Chapter 7. Among other things, the successful PROPOSER must be a U.S. entity, although it can have foreign ownership, and the PROPOSER, or its owners, must also have very solid financial backing. HECO also requires a detailed understanding of the organizational structure of the entity or entities proposing to undertake this Project and requires the presentation of the management structure and personnel who will be responsible for the execution of this Project and its long-term operation.

THE PROPOSAL AND EVALUATION PROCESS

The schedule for evaluation and selection of a Proposal is set forth in the RFP. There is a conference open to all PROPOSERS on June 5, 1989. All those who intend to submit a Proposal are requested to so notify HECO by

June 15, 1989. Identification of team members and a firm statement of an intent to propose are required by August 1, 1989. There will be separate, private meetings with the PROPOSERS beginning on September 5, 1989. Technical Proposals are due on November 1, 1989, and Commercial Proposals on December 1, 1989. HECO will qualitatively evaluate the Proposals and establish a short list.

HECO will then conduct a more detailed evaluation of the short listed Proposals. These evaluations will lead to negotiations with one or more PROPOSERS. It is planned to have one or more power purchase agreements negotiated for signature by October 1, 1990, with the intent of reaching a decision by December 31, 1990.

It is recognized that PROPOSERS will likely not have reached agreement on rights to sufficient geothermal resources by the time Proposals are submitted. PROPOSERS selected for the short list, however, will be expected to begin or continue negotiations for the resource so that agreements are in place by October 1, 1990. In this regard, the major existing geothermal leaseholders have expressed their willingness to cooperate with PROPOSERS on this Project. Hawaiian Electric will not sign a power purchase agreement that does not contain rights to sufficient geothermal resources for full development of the Project.

Hawaiian Electric Company urges those organizations which have the requisite technical, managerial, and financial expertise to propose on this Project. The Project promises to be one of the more interesting and demanding electric power projects of this century, with significant exposure around the world for the organization which develops this Project.

EXECUTIVE CHAMBERS

HONOLULU

JOHN WAIHEE
GOVERNOR

April 28, 1989

Mr. Harwood D. Williamson, President
Hawaiian Electric Company, Inc.
900 Richards Street
Honolulu, Hawaii 96813

Dear Mr. Williamson:

I am pleased to affirm the strong and continuing support of the State of Hawaii for the Hawaii Geothermal/ Interisland Transmission Project, and endorse the joint efforts of the State and Hawaiian Electric Company (HECO) in seeking proposals for the development of our State's geothermal resources. With cooperative assistance from the State and HECO, I am confident that the creative forces of the private sector will provide viable proposals to insure Hawaii and its people a long-term source of electrical power that is generated from our own renewable energy resource base.

I believe that we mutually and realistically recognize the enormous scope of the venture. While the benefits are great, so too are the risks. To the extent necessary and possible, the State of Hawaii will act to facilitate the efforts of the private sector in determining the financial and technical feasibility of this project and in constructing viable proposals.

I have directed those of my Cabinet most directly involved in the development of geothermal resources to lend the assistance that will be needed for private sector interests to meaningfully evaluate the viability of developing geothermal resources in Hawaii. To that end, the State will establish and staff a public documents room; this will be a source of technical and economic information specifically pertinent to this project. In addition, a facility will be available to serve as a permit information and coordination center, a repository of relevant laws, rules, and permitting requirements. In general, these facilities will centrally locate and make easily accessible the documents which we believe will be useful to those preparing responses to the request for proposal to be issued by HECO.

The State can, and will, be helpful in other ways as well. I have recently commissioned the preparation of a master development plan. The objective of this effort is to determine citizen concerns and, with input from the community, format the best means by which to develop several hundred megawatts of geothermal power on Hawaii. Public involvement is crucial to this study, and my goal is to seek the cooperation and support of Hawaii's citizens for this renewable energy project. I will actively work for a coordinated effort with Federal agencies and county governments toward this objective.

Based on the results of this development plan, the State will move to obtain what permits it can for the commercial project, including the preparation of appropriate environmental impact statements, and will work closely with the selected developer to facilitate the acquisition of all other required permits. Recognizing the critical nature of issues associated with this venture, my Administration will work cooperatively with all parties involved to help insure its timely progress. If deemed appropriate, I will personally involve myself in addressing issues that may be impeding the advancement of this project.

Finally, I recognize that the State must be receptive to ideas for public financial assistance if such assistance is necessary. The magnitude of the venture precludes significant direct funding by the State; however, there may be mechanisms for indirect financial support. My Administration is willing to explore such mechanisms with those prospective developers whose proposals are judged technically viable, but only if we are satisfied the project cannot be accomplished without State support.

We are indeed fortunate to have a natural resource which offers the potential of energy security for Hawaii's people and its economy. I strongly believe the development of geothermal energy is a key to achieving the State's goal of significant reduction in imported oil. To this end, I again pledge my personal support and the support of my Administration.

With kindest regards,

Sincerely,

JOHN WAIHEE

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-0001

Harwood D. Williamson
President and
Chief Operating Officer

May 1, 1989

TO: Potential Proposers

SUBJECT: Request for Proposal for Geothermal/Interisland Transmission Project

Hawaiian Electric Company and the State of Hawaii have worked together on a cooperative basis since 1982 to bring about the development of deep water cable transmission technology in the hope that one day the geothermal potential of the Big Island might be utilized to meet a significant portion of the electrical energy needs of the island of Oahu. Research on the deep water cable system is nearly complete and it is time to take the next step and pursue commercial development of the geothermal resource and the cable system.

Although this request for proposal is a Hawaiian Electric Company effort, HECO clearly recognizes that it would most likely not produce any results if it were not for the concurrent support of the State of Hawaii to expedite the acquisition of transmission corridors, streamline the permitting process, prove the extent of the geothermal resource, and complete the final phase of the deep water cable research program.

HECO supports the State's goal of reducing Hawaii's dependence on imported oil and believes that this cooperative effort has the highest potential for making a significant impact on efforts to achieve that goal. We are grateful for the cooperative assistance from the State and look forward to your response.

Harwood D. Williamson

Maui Electric Company, Ltd. • 210 West Kamehameha Avenue • PO Box 398 • Kahului, Maui, HI 96732-0398 • (808) 871-8461

April 28, 1989

Arden G. Henderson
President

Mr. H. D. Williamson
President
Hawaiian Electric Company, Inc.
P. O. Box 2750
Honolulu, HI 96840-0001

Dear Dan,

As President of Maui Electric Company (MECO), I am writing to express keen interest in the possibility of obtaining power from the 500 megawatt Hawaii geothermal/interisland cable project which HECO is now soliciting.

I ask that an additional requirement be included in HECO's request for proposals for an assessment by the proposers as to whether an electrical tap on Maui is technically feasible. We believe the inclusion of our request may provide a benefit to all parties directly interested in HECO's RFP. However, we are cognizant that without HECO's Power Purchase Agreement ("PPA"), it is unlikely that MECO's purchase of up to 50 megawatts of electricity could alone justify the cost to develop and transmit the Big Island's geothermal energy. Hence, any definitive discussions regarding MECO's purchase of electricity will not be entertained unless and until a PPA has been executed by the successful proposer and HECO. For purposes of determining the technical feasibility of a possible tap, proposers should be required to evaluate and discuss, among other things, whether or not such a tap might cause uncontrollable disturbances to either MECO's or HECO's system if one or the other system were to experience a disruption.

Assuming that the analysis determines technical feasibility, and after HECO successfully negotiates a PPA with the owners or operators of the geothermal project, MECO will be very interested in discussing with the geothermal developers the possibility of purchasing up to 50 megawatts of electricity to be delivered after 1995. We will be pleased to have qualified developers discuss with and propose to HECO, on MECO's behalf, the technical feasibility of providing a tap on Maui.

Please include this letter in the RFP so that interested parties will be aware of MECO's interests.

Sincerely,

Arden G. Henderson

CHAPTER 1: PURPOSE AND GOALS

1.1 SOLICITATION

The Hawaiian Electric Company, Inc. (HECO) is requesting Proposals from qualified organizations to deliver for sale to HECO up to 500 megawatts (MW) of electricity generated from geothermal resources on the island of Hawaii and transmitted to HECO's system on Oahu. These organizations should submit Proposals to finance, design, construct, install, own, operate and maintain the geothermal resource development, electric power generation and interisland transmission project in the state of Hawaii solicited by this Request for Proposal (RFP).

The successful PROPOSER to this solicitation (the DEVELOPER) will develop or cause to be developed the geothermal resources on the island of Hawaii, convert or have converted those resources to electricity and transmit or have transmitted to Oahu by means of an overland and submarine interisland cable transmission system up to 500 MW of electricity for purchase by HECO. This integrated geothermal resource development, electric power generation and interisland transmission system is hereinafter referred to as the Project. It is desired that delivery of geothermally generated electricity from the Project commence early in calendar year 1995.

All qualified organizations are strongly encouraged to submit a Proposal. A qualified organization is one that, alone or in conjunction with other participants, has the technical, managerial and financial expertise to develop the project and who has, or parent or other guarantor has, the financial strength necessary to assure HECO of the successful completion and continuing operation of the Project.

The desired schedule for the RFP is as follows:

Issue request for Proposals	5/1/89
Open PROPOSERS conference	6/5/89
Return Inquiry Acknowledgment form (Exhibit 2.1A)	6/15/89
PROPOSERS return Intent to Propose form (Exhibit 2.3A) and identify team makeup and structure	8/1/89
Meetings with intended PROPOSERS	9/5/89
Technical Proposals due	11/1/89
Commercial Proposals due	12/1/89
Complete preliminary evaluation and prepare short list	2/1/90
Complete evaluation and negotiation of draft contract with selected PROPOSER(s)	10/1/90
Decision target date	12/31/90

The meeting with intended PROPOSERS in September 1989 will be mandatory for those who intend to respond. All 1989 meetings will be in Honolulu, Hawaii.

HECO intends to develop a short list of PROPOSERS upon completion of the preliminary evaluation of responses to this RFP. Selection for this list will be based on HECO's evaluation of the responses and such factors as it believes appropriate to best meet HECO's needs. To make a final determination, HECO intends to conduct detailed discussions with each of the PROPOSERS on the short list. It is anticipated that negotiations of the provisions of a power purchase agreement (PPA) will be undertaken with selected PROPOSER(s) on the short list and a final decision made in December, 1990.

HECO intends to execute a PPA with the successful PROPOSER (DEVELOPER). This PPA will obligate the DEVELOPER to sell and HECO to buy AC electrical energy at a designated point of interconnection on the island of Oahu. HECO does not intend to own any portion of the Project and this solicitation should not be interpreted as a solicitation by HECO for any ownership interest in the Project.

HECO will not pay for any of the costs incurred by PROPOSERS relating to this solicitation.

The information contained in this RFP is drawn from a variety of sources and represents the best efforts of HECO to present information useful to potential PROPOSERS in preparing Proposals in response to the RFP. However, HECO makes no warranty with respect to the information contained herein, and the information contained herein should not be be construed as representations of HECO with respect to the legal, economic or business circumstances of HECO, actions of the State of Hawaii, or other conditions or circumstances affecting the geothermal development, electricity rates or service or similar matters.

1.2 ROLES AND OBJECTIVES

1.2.1 HECO

The objective of this RFP is to execute a satisfactory PPA between HECO and the successful PROPOSER to supply on a long-term basis at an agreed upon cost per kilowatt hour up to 500 MW (net) (or any agreed upon increment thereof) of geothermally-generated electrical energy. This electricity would be transmitted from the island of Hawaii to a point of interconnection with HECO's system on Oahu via an overland and undersea transmission system. This is shown in diagrammatic form on Figure 3.5B. A subsidiary goal is evaluating the technical feasibility of a tap on Maui.

1.2.2 STATE OF HAWAII

Increased energy self-sufficiency is a specific State objective expressed in the Hawaii State Plan (Chapter 226, HRS). In order to achieve this objective one of the policies stated in the Hawaii State Plan is to, "...promote the use of renewable energy sources" (Section 226-18 HRS). Further, one of the priority guidelines in the Hawaii State Plan is "...commercialization of renewable energy resources" (HRS 226-1013[f]).

In Hawaii, the term renewable energy resources is almost synonymous with indigenous energy resources. Geothermal may be the only indigenous resource available in large quantities in Hawaii, whose conversion to base-load electricity may be commercially viable in the near future.

The State of Hawaii is increasingly interested in renewable, indigenous resources to help meet its energy needs. The Government of Hawaii, both the Administration and the Legislature, have expressed support for policies designed to shift electricity generation toward geothermal energy as a source to supplement existing oil-based electric power generation.

In support of the State's goal to have indigenous energy resources developed in order to achieve greater independence from imported petroleum, the State of Hawaii has stated that it will assist the DEVELOPER in obtaining the necessary permits and preparing the necessary environmental impact assessments and/or statements for the Project. Please see Governor Waihee's letter to H.D. Williamson (attached following the Executive Summary).

The State has already completed extensive environmental reviews for the cable system (August, 1987) and for the geothermal development (March, 1989). The State has continued this process by issuing on March 10, 1989, a Request for Proposal for the "Development of a Master Plan, Transmission Line Routing Study, and Environmental Impact Statement for Hawaii's Proposed Geothermal/Inter-Island Cable Project," included here as Appendix C. The master plan and transmission study should be completed in early 1990. It is anticipated that an EIS will be initiated and completed as soon as practicable after enough elements of the master plan and transmission routing report are available. The

EIS will be prepared around a logical but theoretical development scenario. When applications for permits are made, it is anticipated that one or more EIS supplements analyzing actual development scenarios will likely have to be performed by, and at the expense of, the Project DEVELOPER.

1.3 HAWAIIAN ELECTRIC COMPANY SYSTEM

HECO is a regulated public utility company that is a wholly owned subsidiary of Hawaiian Electric Industries, Inc. (HEI), a publicly held corporation. Located on the island of Oahu, HECO is responsible for providing electrical service to a population of approximately 830,000 residents, a visitor industry that hosts approximately six million people a year, and several military installations.

The HECO system is presently comprised of 16 oil-fired generating units located at three sites -- Honolulu, Waiau and Kahe. Non-firm energy is also purchased by HECO from various small, independent power producers. Firm capacity, currently provided entirely by HECO, totals 1,277 MW, which is expected to increase to 1,608 MW by the end of 1992 when two cogeneration facilities are expected to be in service. At that time the generation mix of the HECO system is expected to be 1,174 MW (73.0 percent) base load, 332 MW (20.7 percent) cycling and 102 MW (6.3 percent) peaking.

HECO recorded a peak demand of 1,068 MW in December, 1988 and produced a total of 6,793,308,000 kilowatt-hours in 1988. Purchased power for the same period was 102,949,600 kilowatt-hours. System load factors range from 73 percent to 80 percent on a weekly basis.

The type of firm capacity that HECO believes is most desirable for its projected capacity requirements after 1992 has the following characteristics:

- <u>Dispatchability</u>

  The generation should be capable of following typical demand fluctuations on a daily basis.

- <u>Cycling Capability</u>

  To complement the committed projected generation mix of base load, cycling and peaking units, the ideal generation unit should be capable of cycling off-line on a daily basis.

- <u>Spinning Reserve</u>

  As an isolated utility, HECO places an emphasis on three second quick load pick-up, i.e., the amount of load that a unit can pick up and sustain within three seconds of a major system frequency excursion.

- <u>Reliability and Availability</u>

  HECO generating units exhibit reliability levels considerably better than comparable units nation-wide. The typical system annual equivalent forced outage rate ranges from two percent to just under four percent. The low forced outage rates reflect HECO's ability to perform efficient and effective maintenance and repair work.

  Typical HECO unit equivalent availability rates range from 91 percent to 94 percent, which allows this isolated utility to maintain a relatively low reserve margin.

It would be highly desirable that future generation additions achieve similar reliability and availability levels.

- <u>Sustained Operation Through Frequency Deviation</u>

  Due to the relatively small size of the HECO system, frequency fluctuations of up to ±0.1 Hz caused by normal transmission switching and cycling units on- and off-line occasionally occur.

- <u>Self-Starting Facilities</u>

  Major generation facilities must be capable of restart in the event of a system blackout due to natural or man-made disaster and/or loss of normal start-up facilities.

- <u>Facilities for Continued Operation</u>

  Major generation facilities must also have sufficient on-site equipment and supplies to maintain continued operation in the event of disruption of supply deliveries for up to one week at the plant and up to one month for the island. Examples would be: chemicals necessary for operation, chemical storage facilities, water treatment and storage facilities, and auxiliary fuels.

1.4 NATURE OF POWER REQUIREMENTS

With the improved economic climate of the mid-1980's, HECO has seen a corresponding increase in peak load. While the growth rate has not returned to the levels seen before the oil crisis of the 1970's, growth is strong and is expected to continue at a moderate 2.2 percent rate.

The geothermally generated electricity sought by this RFP may not exhibit all of the ideal firm capacity traits described in Section 1.3. If the Project's proposed firm capacity additions cannot meet these requirements, the value of such capacity to HECO in the operation of its system would be lessened since additional measures would need to be implemented by HECO to compensate for any deficiencies.

Based on current forecasts of load, and presuming that geothermal capacity will not be able to provide significant cycling or quick load pick-up capabilities, it is estimated that geothermal capacity could be purchased by HECO in phased amounts beginning in 1995 with about 125 MW and increasing thereafter to the approximately 500 MW being sought by the RFP.

A more detailed description of HECO's projected needs is found in Section 5.1.

1.5 ORGANIZATION OF THE RFP

This RFP is organized into eight chapters and three appendices.

Chapter 1 explains the overall intent of the RFP with respect to the involvement of the State of Hawaii in this solicitation and the interest of HECO in purchasing up to 500 MW of geothermally generated electrical energy.

Chapter 2 sets forth specific instructions to assist in the preparation of a Proposal. The resultant Proposals should contain sufficient information and of a comparable nature so that HECO may evaluate all Proposals fairly and on a common basis.

Chapter 3 describes the types of technical information requested of the PROPOSER. This information may be based on conceptual, not final, designs. The intent of requesting the information, however, is to allow HECO to determine with some confidence that the reliability and availability values proffered by the PROPOSER are attainable with the design and assumptions made in the Proposal.

Chapter 4 presents the reliability requirements for the Project and identifies the related information to be provided by the PROPOSER which will allow HECO to assess the projected level of reliability of the electricity supply to be offered. Both HECO and the State desire that the Project evidence a high degree of reliability because a significant portion of the Oahu electric load will be supplied by the Project.

Chapter 5 sets forth a schedule for HECO's ability to purchase power from the Project based on presently available information. This chapter also requests certain schedule related information to assure HECO that the PROPOSER'S plans are integrated with HECO's requirements for power.

Chapter 6 indicates the permitting, regulatory and environmental framework within which the Project will exist.

Chapter 7 contains three separate sections. The first discusses the financial framework for the Project. The second describes those major provisions that HECO will seek to include in the PPA. The last section requests some very specific legal and financial information to assist HECO in determining that the PROPOSER is capable of fulfilling the Proposal commitments.

Chapter 8 describes MECO's system and its request to determine if a "tap" for up to 50 MW on Maui from the Project's transmission system is technically feasible. MECO will not entertain any proposal for a power purchase agreement until and unless a PPA with HECO has been executed. HECO will have first right to purchase all power produced by the Project.

Appendix A provides summary information on the geothermal resource to facilitate the initial screening effort for prospective PROPOSERS. It comprises a summary of public information. No representation is made that this information is complete, all-inclusive or accurate.

Appendix B presents a summary of publicly available permitting and environmental information. HECO does not represent that this summary is complete, accurate or all-inclusive and the PROPOSER should consider this summary as provided for information only.

Appendix C is the State's Request for Proposal for the preparation of a master plan and a programmatic Environmental Impact Statement.

1.6 EVALUATION CRITERIA

1.6.1 PRELIMINARY EVALUATION

All Proposals received will be evaluated. The first phase of the evaluation will consider the overall technical and commercial merits of the Proposals with respect to each other. Those which in HECO's judgment have a high probability of being eligible for the PPA negotiation phase will be included on a short list. HECO will request additional information from the PROPOSERS as necessary to make the Proposals comparable and/or request additional information where HECO is unclear of the intent of a PROPOSER.

In the event that a Proposal is not included on the short list, a notice will be sent to the PROPOSER.

1.6.2 COMPREHENSIVE EVALUATION

If a Proposal is included on the short list it will be subject to a comprehensive evaluation. This will include a substantive evaluation of the technical and commercial Proposals.

The technical Proposal evaluation will be conducted to determine the relative technical merits of the Proposals. Both the capabilities of the Project design as proposed and the technical expertise of the PROPOSER will be considered. The evaluation factors are described in Section 1.6.3. The technical Proposal evaluation will conclude in a determination of the relative ability of the PROPOSER to undertake and complete a geothermal resources/interisland transmission project of the size and complexity sought by this RFP.

The commercial Proposal evaluation will be conducted to determine the management performance potential and the economic and financial feasibility of the proposed Project. Both the merits of the Project as described by the PROPOSER and the managerial expertise and financial strength of the PROPOSER will be considered. The evaluation factors are described in Section 1.6.3. The commercial Proposal evaluation will conclude in a determination of the relative attractiveness to HECO of the commercial offers.

HECO will ask questions of the PROPOSERS as necessary during the course of the above evaluations.

HECO may select one or more of the Proposals evaluated during this phase for detailed negotiations leading toward a PPA. These negotiations may overlap the final portion of the comprehensive evaluation. If a short-listed Proposal is eliminated, the PROPOSER will be notified.

HECO's objective is to enter into a PPA with a single PROPOSER.

1.6.3 CRITERIA

The following is offered as a guide to HECO's evaluation factors.

1.6.3.1 Technical Proposal

The evaluation factors are as follows:

a. Project Performance

1. Dispatchability.
   The ability of the generating resource to be integrated into the dispatch system of HECO. This includes the ability of the generating resource to follow load fluctuations on a continuous basis.

2. Cycling Capability.
   The ability of the generating resource to load follow to any degree, and to be capable of being turned down on a daily basis.

3. Spinning Reserve and Operational Flexibility.
   The ability of the generating resource to provide in three seconds and sustain indefinitely a sudden increase in load. Also, the ability of the resource to provide voltage and frequency support during abnormal conditions, including transient disturbances which could disrupt system stability.

4. Reliability and Availability.
   The ability of the generating resource to deliver firm power on a regular basis which will maintain reliability levels equal to or better than conventional alternatives available to HECO.

5. Self-Starting Facilities.
   The ability of the generating resource to restart independently and provide maximum capability in the event of a system black-out. Restoration time to maximum capability is an important factor.

b. Project Design

The technical adequacy of the design represented by the:

1. Geothermal resource development
2. Energy gathering system
3. Power production facilities
4. AC collection system
5. Overhead DC transmission
6. Submarine transmission
7. Converter terminals

1.6.3.2 Commercial Proposal

The evaluation factors are as follows:

1. Power delivered on a schedule to meet HECO's needs, including reasonableness of PROPOSER'S permit schedule.

2. Relative environmental and social impact.

3. Adequacy and completeness of the financing plan, including financial condition of the proposed funding sources.

4. Degree of priority placed on Project by PROPOSER'S management and ability of the proposed management structure to undertake and manage a project of this size and complexity, including experience with other large power projects.

5. Price for the power offered for sale to HECO.

1.7 RFP DEFINITIONS

DEVELOPER, where used, refers to the successful PROPOSER, i.e. that PROPOSER with whom HECO executes a PPA. Information required of the DEVELOPER is described in the RFP. Additional information may be required of the DEVELOPER subsequent to the Proposal.

First phase of power refers to the approximately 125 MW increment (or such other increment selected by the PROPOSER) to be available in 1995.

GRS refers to the Geothermal Resource Subzone(s), the land use designation for geothermal development. See Appendix B, Section B.1.1.6.

HECO is the Hawaiian Electric Company, Inc., the electric utility on the island of Oahu. HECO will be provided the first option to purchase all of the geothermally generated power. HECO is a wholly owned subsidiary of Hawaiian Electric Industries, Inc.

HELCO is the Hawaii Electric Light Company, Inc., the electric utility on the island of Hawaii. HELCO is a wholly owned subsidiary of HECO.

KERZ refers to the Kilauea East Rift Zone on Hawaii, an area presently designated for geothermal development.

MECO is the Maui Electric Company, Ltd., the electric utility on the island of Maui. MECO is a wholly owned subsidiary of HECO.

PPA refers to the Power Purchase Agreement executed by HECO and the DEVELOPER.

Project refers to the generation of electricity from geothermal resources in the KERZ on the island of Hawaii and transmitted to the point of interconnection on the island of Oahu and sale to HECO.

Project Team refers to those organizations or parties responsible for proposing and accomplishing all phases of the Project. The Project Team includes the legal entity responsible for the Project (i.e., the PROPOSER), the subcontractors, technology licensors, and host-site offerors that are identified in the Proposal. The Project Team also includes those guarantors of Project completion, lenders of funds to conduct the Project, and, if appropriate, insurers of the Project. Where a legal entity has been or will be created to conduct the Project, the participating organizations or parties (partners, joint venture members, etc.) are also considered to be Project Team members.

PROPOSER refers to the organization responding to this RFP. All information requested of the PROPOSER in this RFP should be presented in the PROPOSAL.

Proposal refers to the technical and commercial Proposals prepared in response to this RFP.

CHAPTER 2: PROPOSAL PREPARATION AND SUBMITTAL

2.1 INQUIRY ACKNOWLEDGEMENT

All entities receiving a copy of this Request for Proposal (RFP) are requested to complete the Inquiry Acknowledgement Form, Exhibit 2.1A, and return it by June 15, 1989. HECO intends to accept Proposals only from entities capable of developing the entire project either directly or through contractors. It is expected that some PROPOSERS will, in fact, be a consortium, joint venture, special purpose corporation, or other entity organized specifically for the purpose of proposing on and developing this Project. Thus, on the inquiry form it is sufficient to indicate that the response will be submitted as a part of the Proposal of a larger organization.

2.2 QUESTIONS AND CLARIFICATIONS

All questions and clarifications concerning this RFP (whether technical or otherwise) shall be directed in writing to John F. Richardson, Jr. of HECO. HECO will issue addenda to the RFP or provide separately such additional or clarifying information as HECO deems necessary to all PROPOSERS.

It shall be the responsibility of the PROPOSER's to advise HECO by October 2, 1989 for the technical Proposal and November 1, 1989, for the financial Proposal of conflicting requirements or omissions of information which require clarification. Those questions not resolved by addenda to the RFP shall be specifically identified in the Proposal together with statements of the basis upon which the Proposal is made as affected by each unresolved question. Addenda to the RFP, if issued, will be furnished only to those companies or groups of companies which indicate in writing, in accordance with Section 2.1, their intent to respond to the RFP.

All requests by regular mail should be addressed to:

Mr. John F. Richardson, Jr.
Geothermal/Interisland Transmission Project
Hawaiian Electric Company
P.O. Box 2750
Honolulu, Hawaii 96840-0001

If sent by overnight mail or courier the address is:

Mr. John F. Richardson, Jr.
Geothermal/Interisland Transmission Project
Hawaiian Electric Company
820 Ward Avenue
Honolulu, Hawaii 96814

Mr. Richardson's telephone number is 808 - 543-4420.

2.3 SUBMITTAL DATE, LOCATION AND INTENT TO PROPOSE

All PROPOSERS intending to submit a Proposal are requested to so notify HECO in writing by 4:00 p.m. Hawaiian time on August 1, 1989. This intent to propose should be evidenced on an Intent to Propose form, Exhibit 2.3A. Only one Intent to Propose form is required for each Proposal to be made. The Intent to Propose form should be submitted by the legal entity designated as the PROPOSER to the addressee shown below.

Proposals are to be prepared in two volumes, a technical volume and a commercial volume. These materials are to be prepared in accordance with Section 2.5, Proposal Preparation.

The technical Proposal is due by 4:00 p.m. Hawaiian time on November 1, 1989.

The commercial Proposal is due by 4:00 p.m. Hawaiian time on December 1, 1989.

All envelopes containing Intent to Propose forms and Proposals are to be marked "CONFIDENTIAL - TO BE OPENED BY ADDRESSEE ONLY" and "GEOTHERMAL/INTERISLAND TRANSMISSION PROJECT" and submitted to:

Overnight mail or courier:

Mr. John F. Richardson, Jr.
Hawaiian Electric Company
820 Ward Avenue
Honolulu, Hawaii 96814

Regular mail:

Mr. John F. Richardson, Jr.
Hawaiian Electric Company
P.O. Box 2750
Honolulu, Hawaii 96840-0001

2.4 PROPOSERS CONFERENCES

An open PROPOSERS Conference will be held at 8:00 a.m. on June 5, 1989, in Hawaiian Electric Company's second floor auditorium at 900 Richards Street, Honolulu, Hawaii.

The purpose of this conference is to answer questions from prospective PROPOSERS about the requirements of this solicitation. Questions should be submitted in writing at least 10 days in advance of the conference. Prospective PROPOSERS are requested to indicate to Mr. Richardson whether they will be attending this conference. Attendance is not mandatory. Copies of the questions and answers will be provided to those who indicate their intent to submit a Proposal on the Inquiry Acknowledgement form.

There will be a second conference beginning on September 5, 1989. This conference will be by invitation only to those who have identified their intent to propose by August 1, 1989. The format for this conference will be separate, private meetings with each intended PROPOSER to allow HECO and the PROPOSER to discuss the Proposal to be submitted. No minutes of such meetings will be made public. These meetings will also be in Hawaiian Electric Company's offices in Honolulu.

HECO does not intend to organize or conduct a visit for PROPOSERS to the potential geothermal resource development site(s) or to the potential transmission routes. Any organizations that wish to visit the Kilauea East Rift Zone (KERZ) on Hawaii or any of the tentative transmission routes must make their own arrangements.

2.5 PROPOSAL PREPARATION

Proposals are to be prepared in two volumes, a technical volume and a commercial volume. These materials are to be prepared in accordance with the following instructions. Each Proposal volume should be organized as shown in Sections 2.5.9 and 2.5.10.

Eight (8) copies of the complete Proposal package shall be prepared and submitted. Proposals which are not prepared and submitted in accordance with these instructions may be considered noncompliant.

2.5.1 PREPARATION

Each Proposal shall be carefully prepared using the exhibits provided. Entries on the exhibits shall be typed, using black ribbon, or legibly written in black ink.

Pages of all except preprinted material should be numbered. The PROPOSER shall assemble in loose-leaf binders or otherwise bind each copy of the Proposal submitted.

HECO does not wish to receive large quantities of catalogs, marketing material or other "boiler plate". All information should be specifically relevant to this Project.

2.5.2 EXHIBITS

The exhibits are to be included as a part of each Proposal. Some of the exhibits are forms to fill out, others are questions with space provided for responses or requests for documents, to be attached. Each PROPOSER should list on the exhibits all exceptions or conflicts between its Proposal and the RFP. If more space is required for this listing, additional pages may be added. The PROPOSER shall assemble all drawings, data, and other information necessary to thoroughly describe an exhibit with the exhibit. If the Proposal deviates from the items described in the exhibits, the PROPOSER should describe in detail each deviation in the Proposal submitted. PROPOSER is advised to submit additional information if the PROPOSER believes that the RFP text contains or implies questions in addition to the exhibits or that such additional information would enhance the Proposal.

2.5.3 LANGUAGE/SYSTEM OF UNITS

Proposals must be written and submitted in English with all technical information, calculations, engineering data and financial data expressed in United States units of measure and currency. It is the responsibility of the PROPOSER to make the necessary translations or conversions and to assure the accuracy of such work, stating clearly the basis for the exchange rates applied to the financial information. Supplementary, preprinted material may be in metric units but must be written in English.

2.5.4 PRICING INFORMATION

Prices and costs shall be quoted in U.S. dollars.

2.5.5 LIMITING CONDITIONS

HECO, prior to or concurrent with the execution of a PPA, reserves the right to:

a. Reject any or all Proposals solely at its discretion.

b. Reject any Proposal which is not complete, not responsive to this RFP or contains irregularities; or waive irregularities in any Proposal that is submitted.

c. Reject any Proposal not received on or before the due date specified.

d. Accept other than the Proposal which offers the lowest price for power.

e. Obtain clarification from PROPOSERS concerning Proposals.

f. Conduct negotiations with one or more selected PROPOSERS.

2.5.6 PROPOSAL COMPLIANCE

The Proposal should be in compliance with the RFP requirements insofar as possible. All deviations from, or exceptions to, the RFP requirements should be clearly delineated in the Proposal. The fact that there are deviations will not necessarily rule against the particular item or PROPOSER.

2.5.7 REPRESENTATIVE

PROPOSER shall include the name, title, address and telephone number of its representative on the appropriate Exhibit 2.5A.

2.5.8 SIGNATURES

Each PROPOSER shall sign the appropriate Exhibit 2.5A with its usual signature and shall give its full business address. Proposals by a corporation shall be signed in the official corporate name of the corporation, followed by the signature and designation of the president, secretary, or other person authorized to legally bind the corporation. The name of each person signing should also be typed or printed below each signature.

A Proposal by a person who affixes to his/her signature the word "president," "secretary," "agent," or other designation without disclosing his/her principal will be rejected. Satisfactory evidence of the authority of the officer signing on behalf of the corporation shall be furnished. Proposing corporations shall designate the state in which they are incorporated and the address of their principal office.

The name of the PROPOSER stated on the Proposal shall be the exact legal name of the entity.

2.5.9 TECHNICAL PROPOSAL

The technical volume shall be organized in the following order:

Exhibit 2.5A
Exhibit 2.7A, if appropriate
Exhibits of Chapters 3, 4 and 8 (as marked on the exhibit)
Any additional information prepared specifically for this Project
Supplemental preprinted material of any kind that PROPOSER wishes to submit

2.5.10 <u>COMMERCIAL PROPOSAL</u>

The commercial volume shall be organized in the following order:

Exhibit 2.5A
Exhibit 2.7A, if appropriate
Exhibits of Chapters 5, 6, 7 and 8 (as marked on the exhibit)
Any additional information prepared specifically for this Project
Supplemental preprinted material of any kind that PROPOSER wishes to submit

2.6 MINIMUM INFORMATION REQUIREMENTS

HECO's intent is to fully and fairly evaluate the Proposals. In part, this will be achieved by seeking comparable information and to that end several standardized forms and series of questions are provided to elicit from the PROPOSERS specific quantitative or qualitative information. This information must be provided as part of a "Base Proposal". If this information is not provided, the Proposal may be rejected as non-responsive. PROPOSERS may submit additional information as long as the requested information is submitted in the Proposal and the other information is clearly marked as "ADDITIONAL".

2.7 INFORMATION CONFIDENTIALITY

HECO intends to maintain the proposal process and the Proposal documents confidential and, therefore, will limit access to those directly involved in the evaluation process.

PROPOSERS submitting information that they consider confidential or proprietary should clearly and specifically identify such information. This should be done by segregating it, placing bars in the margin, or otherwise providing a notation as to what portion of the material is to be treated confidential, and placing the following notation on the bottom of the Proposal page that contains confidential information. "This page contains confidential or proprietary information." HECO will make every effort to maintain such confidentiality. PROPOSERS are asked to refrain from indiscriminate requests for such confidentiality. The Proposal should also contain Exhibit 2.7A, if appropriate.

2.8 PROPOSAL FEE

The Technical Proposal must be accompanied by a non-refundable fee of $2,500. The check should be made out to Hawaiian Electric Company, Inc.

CHAPTER 3: TECHNICAL INFORMATION

HECO will not be the owner or operator of the Project. Thus, this RFP is performance related, rather than a set of detailed equipment specifications. In an effort to impose minimum constraints and provide maximum flexibility for the PROPOSER'S design, development, manufacturing, construction and operations, the technical information included in this chapter is limited to the following:

- Conceptual description of the components of the geothermal resource production, electric power generation and AC and DC transmission systems,
- Requirements for successful integration of the geothermal power into the HECO networks,
- Environmental conditions which may impact the PROPOSER'S design philosophy, and
- Standard practices, local, state, and national, which should be considered in the development of the Proposal.

A series of questions and requests for data are included in the RFP and it is anticipated that the responses will reveal how the PROPOSER intends to meet the goals and requirements of the RFP, including integrated technical elements, financial details, and performance guarantees. These responses will be critical to the evaluation process, and the information provided in the responses may become part of the PPA between HECO and the successful PROPOSER.

The purpose of the questions and responses sought in this Chapter is to provide HECO with confidence that the reliability projections set forth in Chapter 4 are supported by competent design, engineering and construction practices.

It is recognized that a significant amount of information is requested in the RFP. However, it is HECO's judgment that the information requested would necessarily be developed in the course of preparing and costing a Proposal for a project of this magnitude. It is recognized that the PROPOSER will not have completed a final design and that information provided in the Proposal will be based on a conceptual approach to the work. As a result, this requested information will not have to be certified or guaranteed by the PROPOSER. However, HECO expects that the final design for the first phase of power incorporated into the PPA will closely resemble the design proposed since HECO will make a selection based, in part, upon its evaluation that such a design, when constructed, will result in the delivery of electricity at the evaluated reliability.

3.1 GENERAL TECHNICAL CONSIDERATIONS

This section presents general technical considerations which are common to all elements of the Project.

3.1.1 SEISMIC DESIGN

The island of Hawaii is located in Seismic Zone 3, as defined in the Uniform Building Code (UBC). The Project facilities on Hawaii must be designed to withstand seismic shocks corresponding to intensity VII and higher on the Modified Mercalli scale. Project facilities on Maui and Oahu should meet the UBC, as appropriate. The governing design code will be the UBC, which should be confirmed in the Proposal. The PROPOSER'S design criteria should reflect a well-defined seismic risk assessment, which should be presented in the Proposal. This assessment should include an explanation of how the proposed design is in conformance with the criteria.

3.1.2 ACTIVE LAVA FLOW CONSIDERATIONS

The Geothermal Resource Subzones (GRS) on Hawaii are located on previous surface lava flows (latest 1955) and are adjacent to land with currently active lava flows to the sea. The Proposal should discuss the measures which would be taken to protect the Project from lava flows and present design features which could mitigate the effects of lava flows on the facilities. The selection of facility locations should be based on a volcanic risk assessment, which should be presented in the Proposal.

3.1.3 MATERIALS CRITERIA

The geothermal steam and fluids contain elements which are erosive, such as silica, and corrosive, such as H_2S. Representative brine/steam chemistry from the Hawaii Geothermal Project - Abbott (HGP-A), an operating 3 MW unit, is given in Appendix A, Section A.5. In addition, the general environment of the Project area is corrosive as a result of proximity to the Pacific Ocean and location in an actively venting volcanic area. Consequently, care must be exercised in selecting facility materials. Since material performance directly affects reliability, HECO is specifically concerned with major facility material selections.

The following general recommendations should be considered when selecting materials. The PROPOSER should carefully evaluate these recommendations and explain in detail in the Proposal agreement with, deviation from, or additions to these recommendations.

- When specifying copper or copper-based alloys, nickel or nickel-based alloys, or silver, substitutes or adequate coatings should be used. These materials can give poor performance when exposed to sulfur-bearing compounds such as hydrogen sulfide.

- Metal plating such as chromium, cadmium or nickel should not be considered for any components.

- Generally, fiberglass reinforced plastics perform well if design conditions permit their use. All above ground fiberglass applications require suitable ultraviolet light absorbers in the outer surface.

- Elastomeric compounds proposed for any components of the facility must be selected to give both chemical exposure and adequate elastic or sealing properties. EPDM Y-267 and Viton generally meet most requirements for a geothermal facility. Neoprene and hypalon may also be considered. Use of natural rubber is not recommended.

- Exterior coating systems for equipment, vessels and piping should be designed to provide optimum performance. Such a system should consider near-white blast cleaning, inorganic zinc primer, epoxy intermediate coat and polyurethane finish.

- Immersion lining systems should be selected to meet the specific process environment. Generally, for temperatures less than 200°F, materials such as coal tar epoxy, epoxy, epoxy-phenolic, vinylesters or epoxymastics can be used.

3.1.4 MATURITY OF TECHNOLOGY

The process and equipment selected for the Project facilities must reflect commercially proven technology available from reputable manufacturers and operating in a similar configuration and capacity. It is recognized that this is a long-term project and technology may well advance before completion of all phases. HECO does not intend to preclude the DEVELOPER from introducing future improvements, but will reserve the right to evaluate and verify the necessity for and maturity of such technology with the DEVELOPER at the appropriate time. The first increment of power due in 1995, however, should be based on currently proven, commercially available technology and equipment.

3.1.5 DESIGN AND CONSTRUCTION STANDARDS

The Proposal should include sufficient information to determine that the Project will be designed and constructed to utility quality standards. Utility standards generally dictate a conservative design. Such a project generally features some redundancy in components critical to plant operation, or specifies equipment with operating margins, or utilizes design margins, e.g. selecting structural steel sized to accommodate future unplanned piping or equipment loads. The minimum requirements of prevailing construction and safety codes shall be met.

3.1.6 LAND USE

Design and construction activities of the Project are controlled, in part, by the regulations governing development in GRS. (See Appendix B, Section B.1.1.6 for a discussion of development possibilities outside the GRS.) These activities are monitored and controlled by the Hawaii State Board of Land and Natural Resources and by the County of Hawaii. The PROPOSER must identify the permits that the PROPOSER considers are required to undertake the activities proposed. The PROPOSER should provide a detailed explanation as to how and when those permits will be obtained. This subject is further discussed in Section 6.1.

The PROPOSER should include a description of the land use requirements that may be imposed upon or associated with the Project.

It is recognized that at the Proposal stage the PROPOSER may not have legal rights to the necessary land or geothermal resources. However, the PROPOSER should seek to describe the present fee and lease ownership interests and indicate how those rights necessary for the Project would be obtained. This subject is further discussed in Section 7.1.3.

3.2 GEOTHERMAL RESOURCE

Considerable information has been collected over the years on the geothermal potential of the KERZ. The only operating geothermal plant in the state, the 3 MW HGP-A, is located there. It is also the location of a proposed 25 MW commercial geothermal power project. A significant amount of information is available in the public document room. A summary of the information has been prepared to assist PROPOSERS in their initial investigations, and has been included in this RFP as Appendix A.

It is anticipated that the DEVELOPER will utilize the geothermal resource with modern wellfield and reservoir management technologies found appropriate in the KERZ. It is likely that the largest cost element within the Project will be the drilling and operation of the three categories of geothermal wells: production, injection and other. It is anticipated that production wells will be clustered on selected locations and directionally drilled to their completion targets to minimize wellpads, roads and other wellfield surface facilities in this active volcanic area. Injection wells will dispose of spent fluids and may maintain reservoir pressure. Deep core holes, exploration wells, observation and monitoring holes would constitute the third well category. A group of original wells must be completed to serve each increment of new generation capacity. A group of replacement (additional or make-up) wells will be required to maintain adequate and reliable wellfield support of each generating unit.

3.2.1 TECHNICAL DATA AND INFORMATION REQUESTS

PROPOSER should:

- Provide a map showing the Project area, proposed exploratory well locations and development plan.

- Summarize its geothermal resource development experience.

- Identify and summarize the qualifications of its geothermal drilling team (engineer, reservoir engineer, geologist, on-site drilling supervisor).

- Present its anticipated drilling program and unit cost estimate for a KERZ geothermal production well, within the context of a multiwell development program.

- State its assumptions with regard to yield per productive well and expected dry hole incidence.

- Describe the wellbore evaluation program and criteria for production casing depth selection.

- Describe and cost estimate the intended flow test program for a newly completed KERZ production well.

- Identify and summarize the qualifications of the well testing team.

- Describe the geothermal waste fluid disposal options intended for evaluation or use.

- Describe the basis on which a load following (daily cycled) energy supply would be provided. Describe what percent reduction from normal daytime production is estimated to be attainable. Describe an alternate option if considered to be more appropriate.

- Describe the reliability intended for the geothermal well fields proposed. Detail the excess steam producing capacity planned to achieve the reliability targeted.

3.3 GEOTHERMAL ENERGY GATHERING SYSTEM

Certain features are desirable in the design, construction and operation of the energy gathering system to promote its reliability and longevity. If the Proposal deviates from these features, explanations for each deviation should be clearly stated. The scope of the energy gathering system extends from the production wells to the clean steam or other working fluid provided to the power production facility. Equipment provided for separating steam and liquid resources, scrubbing the steam and controlling the process should be included in this system.

The PROPOSER should provide a schematic and a map of meaningful scale depicting the geothermal field, well pads, and energy gathering system. It should be clearly indicated whether the PROPOSER is designing one gathering system serving all the geothermal power production facilities or separate gathering systems for each power facility. If the gathering systems are independent, the degree of interconnection, if any, should be shown.

The PROPOSER should describe the overall design and operating philosophy for the energy gathering system. This specifically should address proposed noise and H_2S abatement controls and methods and should describe how the brine/steam flow(s) will be managed in the event of a turbine trip.

Sections 3.3 and 3.4 are written on the assumption that the PROPOSER will use a conventional geothermal steam turbine power cycle. However, the PROPOSER may choose to use an alternate cycle, such as binary. If an alternate system is selected, the PROPOSER should supply information equivalent to that requested.

3.3.1 PIPING SYSTEMS

All piping systems should conform to the current edition of the American National Standard Code for Pressure Piping. Currently, the code with jurisdiction is ANSI B31.1 (Hawaii Administrative Regulations, Title 12, Subtitle 8, Chapter 225).

The piping system design should provide for continuous drainage and removal of condensibles from the steam piping. The PROPOSER should describe the consideration given to access for operation, inspection and maintenance of the piping system.

Maximum steam and liquid velocity criteria should be provided. The criteria should be in accordance with acceptable utility industry standards.

The PROPOSER should demonstrate that piping will be supported and anchored to prevent excessive movement and to limit the effect of reactions on the equipment served, taking into account the expansion and flexibility required to maintain pipe stress within acceptable limits and to preclude failure in the event of earthquake or an accident which could rupture other lines attached to the equipment.

3.3.2 SEPARATORS AND SCRUBBERS

These vessels should be designed in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII.

The locations, expected performance and rationale for the selection of the separators and scrubbers should be provided.

3.3.3 CONTROL SYSTEM

The PROPOSER should describe, in general terms, the proposed control system. A distributed control system with independent microprocessors in the energy gathering system is considered to provide the greatest operating flexibility and reliability. Departure from this concept should be supported in detail.

3.3.4 TECHNICAL DATA AND INFORMATION REQUESTS

Since the process and physical configuration of this Project are not specified, the data requested is general in nature and is intended primarily as a guide to demonstrate the type of information HECO considers necessary for a full and fair evaluation of the Proposal. The PROPOSER is advised to furnish all data and information requested to the fullest extent possible.

a. Drawings

- Maps or schematics of the area showing access roads, well pads, pipelines and power production facilities
- General layout drawings

b. Criteria

- Applicable piping code (reference only is sufficient)
- Steam and liquid velocities
- Materials of construction
- Volcanic and seismic risk assessments

c. Equipment Descriptions (configuration, quantities, operating characteristics, primary materials of construction)

- Pumps - wellhead or downhole
- Wellhead equipment
- Steam/brine separation and scrubbing equipment
- Steam separation/cleanup equipment
- Piping
- Process valves
- Control valves
- Control system

3.4 ELECTRIC POWER PRODUCTION FACILITIES

It is anticipated that the Project will be constructed in phases, keyed to geothermal development, including proof of resources, and HECO's power requirements (c.f. Section 5.1). The exact definition of the equipment interface between the energy gathering system and the electric power production facilities may be adjusted to suit the process or the needs of the proposing organization.

The PROPOSER should provide a map or schematic at a meaningful scale of the proposed development area, locating the electric power production facilities and depicting the timing of their development.

The PROPOSER should provide typical plot plans for all facilities required for the first phase of electric power production. The PROPOSER should also provide conceptual facility layouts, plan and elevation, showing the major equipment and component for this first phase.

The PROPOSER should describe and explain the design criteria/philosophy for the electric power production facilities and discuss the rationale for selecting the particular power cycle and major equipment. This philosophy should include off-normal as well as normal operation. For example, what happens to the steam when the plant trips or is shut down for maintenance? Will silica be a problem in the steam and/or waste water? If yes, how will it be handled? Will wet cooling towers be used? What is the backup equipment criteria for major plant equipment, i.e. 100 percent standby, three 50 percent units? How much performance margin is provided in each major piece of equipment?

It is acknowledged that many different plant cycles and equipment configurations may be utilized for this Project. The intent is not to limit creative Proposals, but to guide the PROPOSER in designing a reliable electric power production facility.

3.4.1 POWER CYCLE/HEAT BALANCE

The PROPOSER should fully describe the planned power cycle for the first phase of power as defined in Section 5.3, whether conventional steam cycle, binary, or combination thereof. If a flash unit is to be used, it should be identified as single or double flash.

A process flow diagram should be presented for the steam production portion of the facility. This should include pressures, temperatures, enthalpies and mass flow rates at major points in the process.

A heat balance should be presented for the turbine and related auxiliaries portion of the facility. This should include all major flow paths and equipment, with mass flow rates, pressures, temperatures and enthalpies at major points in the cycle.

3.4.2 CIVIL/STRUCTURAL CONSIDERATIONS

All engineering and design should comply with the Uniform Building Code, current edition, all Hawaii state and local codes and regulations and applicable industry codes and specifications.

Structures should be designed for Seismic Zone 3.

All steel structures, including embedded steel, should be protected from corrosion related to the location and nature of the facilities.

Concrete should be designed for both strength and durability, with proper attention to minimizing corrosion of the reinforcement.

Cooling tower concrete basins should be protected against corrosive conditions, both chemical and biological in origin.

All structures should be designed to withstand the applicable loads, including static, dynamic, hydrostatic, seismic and wind loads.

3.4.3 TURBINE-GENERATOR CONFIGURATION

The turbine-generator(s) selected should be designed, constructed and installed to utility quality standards. The unit(s) should be suitable for continuous operation at maximum capability. Normal operation will be base loaded, but the unit(s) should be capable of operating under automatic load dispatch with other units of an interconnected system.

Because proper selection of materials will directly and dramatically affect plant reliability, HECO will evaluate material selections. The following is a list of material recommendations or design features which should be considered.

- Copper bearing materials should not be used in areas exposed to geothermal steam.
- Aluminum bearing stainless steel materials should not be used in areas exposed to geothermal steam.
- Impingement shields or moisture collecting devices should be provided for each turbine stage to protect the turbine casings from moisture erosion.
- Moisture should be removed continuously from all turbine stages through stainless steel orifices.
- Close contacting steam joint surfaces subject to erosion and corrosion damage should be stainless steel or have stainless steel inserts or inlays to permit easy replacement or repair.
- Moisture erosion protection should be provided on turbine blades in all rotating stages where excessive blade erosion could occur.
- Rotating blades and root fasteners should be rugged with a low stress level to reduce the possibility of stress corrosion cracking.
- Rotors should be solid (integral wheel) construction and shrunk-on parts, such as couplings and thrust collars, should be avoided.

- Overpressure relief diaphragms containing copper bearing materials should be avoided.

- All stainless steel components, which are to be welded or fabricated by welding, should be Type L (low carbon) grade.

3.4.4 OTHER MECHANICAL SYSTEMS

The Proposal should include descriptions of major systems or items of equipment, including configuration, quantities, operating characteristics and materials of construction. During the Proposal review process, the systems and equipment will be analyzed for appropriateness, redundancy, capacity and materials of construction.

Following is a list of equipment or systems which could be incorporated into this Project. Inclusion on this list is not meant to imply that this particular equipment or system must be present in the PROPOSER'S design, but to indicate the types of equipment which should be discussed in the Proposal.

- Steam condenser, direct contact or surface
- Vacuum ejectors/vacuum pumps/compressors
- Cooling tower
- Various pumps such as condensate, cooling water and reinjection
- Heat exchangers
- Valves
- Brine collection/concentration/separation equipment
- Flash vessels
- Waste water disposal system
- Solids handling equipment
- Chemical feed equipment

- H_2S abatement system
- Steam bypass system

3.4.5 ELECTRICAL SYSTEM

The design of the power production facilities electrical system should meet the requirements of the current revision of the National Electric Code and the National Electrical Safety Code.

Unit single line diagrams showing major equipment ratings should be provided. Generator and major transformer electrical data should be furnished. The protective relaying philosophy should be described.

Corrosion due to steam/brine constituents or atmospheric conditions will likely result in rapid deterioration of copper, copper alloys, cadmium plating and silver. All copper and copper alloy wiring, tubing and parts should be tinned or covered with a protective coating which is effective against corrosive compounds, including hydrogen sulfide, ammonia and salt contamination.

Copper and bronze parts of all relays and instruments should be plated with zinc chromate, tin alloy, gold, platinum or equally effective materials.

All outdoor mounted electric equipment enclosures should be rated NEMA 4X.

Electronic cabinets to be located indoors should be sealed construction (NEMA 12). Those requiring forced air ventilation should be furnished with potassium permanganate type H_2S filters at each air intake point.

Electrical switchgear located outside of clean rooms should be oil-filled or vapor sealed against the geothermal atmosphere.

3.4.6 INSTRUMENTATION AND CONTROL SYSTEM

All instrumentation and control applications should conform to applicable sections of the current revision of the ASME Code for Pressure Piping, National Electric Code and Instrument Society of America (ISA) recommended practices.

Design of the proposed control system should accomplish the following objectives.

- Maintain the facility in a safe condition at all times.
- Mitigate the effects of abnormal process conditions, load upsets and equipment malfunctions on facility operations.
- Reduce the number of forced outages and spurious trips.
- Minimize the effects of corrosion and scaling through proper equipment and material selection, equipment location and environmental control.

A central control room is suggested, either for each electric production facility or the facilities collectively. A computer-based distributed control system with programmable controllers would seem to offer the greatest flexibility and reliability. To minimize the effects of corrosion on sensitive control equipment, the control room design should consider redundant air conditioning units.

Consideration should be given to the effects of corrosion and scaling on instrument selection, installation and operation. Bronze and other copper bearing alloys should be avoided. Diaphragm seals should be considered where appropriate to prevent sensing line plugging and to isolate instruments from severe process conditions.

3.4.7 TECHNICAL DATA AND INFORMATION REQUESTS

Since the process and physical configuration of this Project are not specified, the data requested is general in nature and is intended primarily as a guide to demonstrate the type of information HECO considers necessary for a full and fair evaluation of the Proposal. The PROPOSER is advised to furnish all data and information requested to the fullest extent possible.

a. Drawings

- Map or schematic of the area showing the proposed location of the electric power production facilities (reference to a similar map in Section 3.3.4 is acceptable).
- Plot plan
- General arrangements, plan and elevation
- Steam production process diagram
- Preliminary heat balance for the turbine-related systems at design capability
- Preliminary heat balance for the turbine related systems at maximum capability

b. Criteria

- Applicable piping code (reference only is sufficient)
- Design criteria
- Steam and liquid velocities
- Materials of construction
- Volcanic and seismic risk assessments

c. Equipment Descriptions (configuration, quantities, operating characteristics, primary materials of construction)

- Turbine generator
- Steam condenser
- Cooling tower
- Steam scrubbing/demisting equipment
- Flash vessels
- Vacuum ejectors/vacuum pumps/compressors
- Pumps
- Heat exchangers
- Tanks/vessels
- Piping
- Valves
- Waste water disposal system
- Solids handling equipment
- Chemical feed equipment
- H_2S abatement system
- Plant control system
- Control valves
- Transformers
- Switchgear
- Uninterruptible power system
- Miscellaneous electrical equipment (cable, cable tray, conduit, etc.)
- Fire protection equipment

3.5 AC TRANSMISSION SYSTEM

The geothermal power transmission system is shown in block diagram form on Figure 3.5A. A simplified route map for the system is shown on Figure 3.5B. These represent the base system configuration for the Proposal.

The AC transmission system includes the collection system for the AC generator output from the various electric power production facilities in the geothermal resource area and, possibly, an interconnecting line on Oahu between the output of the Waimanalo converter and the Aniani Substation. The AC collection system includes equipment and facilities in addition to the AC transmission lines, and thus this section contains information on that equipment as well as the transmission lines. However, for guidance regarding a possible short AC line (1/4 to 3 miles) on Oahu, the PROPOSER should use only the paragraphs of this section which apply to AC lines. A description and details of the connection to the Aniani Substation are in Section 3.8.

The AC collection system consists of facilities connecting the generator step-up transformers to the Puna converter terminal. These facilities may include circuit breakers, switches, substation buswork, and transmission lines.

The PROPOSER should provide a map or schematic of meaningful scale depicting the AC collection system planned for the KERZ. The PROPOSER should also provide a single line diagram for the collection system. It is recognized that the Project may be built in phases and that plans for the later additions are preliminary and may be subject to modification at a later date.

The PROPOSER should describe the overall design philosophy for the AC transmission system, including materials of construction, consideration of the adverse physical environment in which the system will operate, conductor configuration and the resultant effects on the reliability and flexibility of the system.

The DEVELOPER will be responsible for route selection, permitting, soil borings, surveying, design, material and labor for structures, conductors, foundations, equipment, and grounding for the complete AC collection system on the island of Hawaii, and the

AC transmission segment on Oahu, if any. Routes and corridors should be independent of the local utility's facilities and franchise rights.

3.5.1 RELIABILITY AND PROTECTION

The AC collection system should be designed with consideration given to system reliability. This reliability may be obtained by multiple circuits of transmission lines, and high reliability substation arrangements and protection schemes.

Transmission line systems may employ double circuit structures, or higher reliability obtained by multiple single circuit lines located so as to minimize the possibility of a single incident affecting more than one circuit.

Substations should be designed with high reliability arrangements such as breaker and a half, double breaker, or ring bus arrangements. Protection schemes should complement the high reliability arrangment by including provisions for second contingency conditions such as stuck breakers, or bus faults, while retaining the ability of the collection system to transmit all or a part of the Project power.

In addition to physical considerations, the AC collection system should incorporate into its design sectionalizing capability which will allow faulted line sections or generators to be isolated and reduce the impact of a single component failure. This may require a single or double loop transmission system with breakers at each generation site. The PROPOSER should discuss the design and how it relates to HECO's reliability criteria.

3.5.2 ELECTRICAL REQUIREMENTS

The PROPOSER should consider the following in design of the AC transmission system:

a. Clearances to ground, other conductors, buildings, and other structures should be in accordance with the latest published version of the National Electrical Safety Code, ANSI C2 (NESC) in effect at the time of Proposal and with the State of Hawaii General Order No. 6, Rules for the Construction of Overhead Electric Lines. For each condition, the more stringent of the two codes should apply.

b. Conductor rating (ampacity) should consider the effects of operation on economics, strength, fittings, and other current and non-current carrying parts.

c. Insulation coordination studies should be performed including the effect of insulator swings, lightning and switching surge performance on the operational reliablity of the line. The Keraunic level for Hawaii is in Section 3.7.1, Table 3.7A.

d. The effects of airborne contamination on insulator selection (see Section 3.7.2.3).

e. The levels of electric and magnetic field strength on and at the edge of the right of way. The State of Hawaii has no regulated levels of field strength. The NESC 5 mA rule should be observed as a minimum.

f. Conductor size and spacing to avoid degradation of television or radio reception in the vicinity of the line. Audible noise should be below the level to cause annoyance to people in the vicinity of the line and should meet local regulations.

3.5.3 STRUCTURAL REQUIREMENTS

The AC transmission system should be designed to withstand, with an adequate factor of safety, the wind loads anticipated. Design bases for AC systems in Hawaii are:

- NESC light loading district
- NESC extreme wind load of 145 fps
- Maximum wind speed of 88 fps.
- Seismic Zone 3

Wood poles, steel poles, lattice structures and concrete poles are used by HECO as appropriate for the local aesthetic, environmental and economic requirements, and topography of the route. HECO selects loading criteria and overload factors as appropriate to the exposure of the lines, reliability requirements and construction materials.

3.5.4 ATMOSPHERIC CONDITIONS

Atmospheric conditions are presented in Section 3.7.1.

3.5.5 OPERATION AND MAINTENANCE CONSIDERATIONS

The output of the individual geothermal facilities will be collected and delivered to the converter (rectifier) terminal located in the Puna District on the island of Hawaii. Design of the AC collection system should provide for normal operation and maintenance so that the reliability of the system will be maintained over its life, and so that maintenance may be performed on the components of the system without adversely affecting the reliability and continuity of power delivery to HECO.

HECO believes that availability may best be assured by use of conservative design assumptions, redundancy, separation of facilities, provision for hot-line maintenance on lines and proper sectionalizing and bypass switches.

3.5.6 TECHNICAL DATA AND INFORMATION REQUESTS

Since actual design details and tower outlines for the AC system are not specified, the data requested will provide HECO with sufficient information to make a full and fair evaluation of the Proposal. The PROPOSER is advised to furnish all data and information requested to the fullest extent possible. The Proposal should include at least the following:

- Map and schematic of the system
- Design criteria
- Materials criteria
- Volcanic risk assessment
- Single line diagram and switching arrangement
- Relay and protection philosophy
- Lightning protection criteria for lines and stations and the calculation methodology.
- Table of clearances to ground, conductors or other circuits, structures of other circuits, conductors to supporting structures, etc. List the clearance required by the National Electrical Safety Code, ANSI C.2 for comparison.

- Loading criteria

  Provide design sketches, with dimensions, of the most common tangent and dead end structures (one each). Include a description of each load case describing the loads (wind), angle capability, tensions, overload factors, broken wire or other unbalanced loadings.

- Conductor information

Conductor size	________	kcmil
Conductor type	________	
Stranding	________	
	Normal	Emergency
Ampacity*	______	________
Maximum conductor temperature rise (°C)	______	________

*Reference the method used in calculating ampacity

- Corona effects

Provide the following information for the line:

A transverse profile showing radio interference (RI), television interference (TVI), and audible noise. The profile should be calculated using maximum line to ground voltage at the line's minimum ground clearance. For RI, an antenna height of 2 meters should be used. Frequency for the RI calculation is 1 mHz. For TVI, an antenna height of 3 meters should be used. Frequency for the TVI calculation is 75 mHz. For audible noise, a receptor height of 1.5 meters should be used.

Fair weather and rain conditions (L50) values are required. The design rainfall intensity for the calculation should be 1 inch per hour.

Include a sketch showing all pertinent dimensions, voltages, and assumptions.

- Electrostatic/Electromagnetic fields

Provide the following for the line carrying normal current and emergency current, both at maximum voltage.

List all assumptions, dimensions and other constants used in the calculations.

	Normal	Emergency
Maximum electric field on the R/W (kV/m)	______	________
Maximum electric field at the edge of the R/W (kV/m)	______	________
Maximum magnetic field on the R/W (mG)	______	________
Maximum magnetic field at the edge of the R/W (mG)	______	________

3.6 HVDC TRANSMISSION SYSTEM

The (AC) electric power generated from the geothermal resource is to be converted to direct current and transmitted to Oahu via high voltage direct current (HVDC) transmission lines. The basic transmission plan will utilize a combination of overhead lines and submarine cables, with a possible intermediate tap at Maui. The DEVELOPER may design and construct the transmission system in a configuration different than that described in the following paragraphs. This is acceptable as long as the final result meets the reliability requirements for electric power as outlined in Section 4. For bid evaluation purposes, however, the PROPOSER should base costs, component designs and construction principles on the ratings, routes, converter sites and system configuration presented in the RFP. Where specific options are to be quoted, they are identified as such. The PROPOSER may propose alternatives to the above, provided the requested information is supplied and the additional information is clearly identified as "Additional".

3.6.1 GENERAL TRANSMISSION PLAN

The geothermal power transmission system is shown in block diagram form on Figure 3.5A. A simplified route map for the system is shown on Figure 3.5B. These represent the base system configuration for the Proposal.

The AC collection system between the various geothermal power production facilities is an overhead transmission system as described in Section 3.5. The AC collection system will connect to a HVDC converter terminal in or near the KERZ (see Figure 3.6C).

The HVDC power from the converter terminal (rectifier) may cross the island of Hawaii via an overhead HVDC line. Two possible corridors for the overhead line on Hawaii are shown on Figure 3.6A. The PROPOSER may use either route on Hawaii in developing the line design and associated costs.

The PROPOSER is also requested to present and cost an option which would utilize a submarine route around the island of Hawaii along the eastern shore to the northern tip of the island. This option is also shown on Figure 3.6A. It will be exercised at the sole discretion of HECO.

The transmission system will cross the Alenuihaha Channel between Hawaii and Maui and either cross Maui overhead and exit near Ahihi or touch down at a point on the southern coast of Maui for re-pressurizing, if necessary, and continue on to Oahu.

The HVDC transmission system then will traverse the Auau Channel between Molokai and Lanai and cross the Kaiwi Channel before terminating on Oahu near Waimanalo where a HVDC converter terminal (inverter) will be located. It will then connect to the

HECO 138 kV system at the Aniani Substation, about three miles from Waimanalo.

3.6.2 CONVERTER AND CABLE TRANSITION LOCATIONS AND TRANSMISSION LINE ROUTES

The location of equipment and transmission line routes generally described in Section 3.6.1 are neither fixed nor final. They are shown on Figures 3.6A, B and C in specific locations for Proposal purposes only. Mileages between terminations and converter terminals are approximate. Exact sites and terminal points are the responsibility of the DEVELOPER.

3.6.2.1 Converter Terminals

The Puna converter terminal (PCT) in the basic system is tentatively located in the KERZ near the center of the geothermal resource subzones (GRS). It is identified as PCT on Figure 3.6A. The exact location of the converter terminal is up to the DEVELOPER, however, the site shown on Figure 3.6A should be used in the Proposal as the starting point for the overhead line options. For the submarine option around the island of Hawaii, the converter terminal would likely be moved to the east end of the GRS for practical and economic reasons. This location is also shown on Figure 3.6A. Photographs of these areas are available in the public document room for review.

On Oahu, the submarine cables will most likely come ashore at Bellows Air Force Base (AFB) near Waimanalo (see Figure 3.6C). A substation site owned by HECO near the corner of Kakaina Street and Kakaina Place would be the receiving point for the geothermal power on Oahu. The Aniani Substation site is located nearly midway between the 138 kV substations of Koolau and Pukele and close to an existing 46 kV right-of-way. The converter terminal could be located anywhere in the area around Aniani, possibly including a possible site on the northern end of Bellows AFB, which is no longer an active flying facility.

3.6.2.2 Overhead Transmission Line Routes

There are three segments of the HVDC transmission system which may involve overhead transmission lines. The length and exact routing are variables depending on the final location of the converter terminals and transition stations. The base system includes:

- A line from the Puna converter terminal to the north end of Hawaii in the North Kohala District where an exit transition station would be located, a distance of approximately 131 miles.

- A line from a landing transition station on the south shore of Maui, possibly near Huakina Bay, to an exit transition station south of Maalaea, perhaps near Ahihi Bay, a distance of approximately 20 miles.

At the PROPOSER'S option there may be a third overhead segment:

- A line on Oahu from a converter terminal near the shore to Aniani Substation, a distance of about three miles.

The line from Puna to North Kohala could take at least two different routes, the shortest being up through the saddle between Mauna Loa and Mauna Kea at altitudes above 6000 feet. An alternate route is along the northeastern shore on the slopes of the Hamakua coast. Both routes are shown on Figure 3.6A and the PROPOSER may use either in costing the base Proposal.

The overhead HVDC line on Maui could run parallel to the southern coastline, probably below the Piilani Highway, but above the Kings Trail (See Figure 3.6B).

3.6.2.3 Submarine Cable Routes

The first segment of submarine cable would cross the Alenuihaha Channel between Hawaii and Maui, a distance of about 42 miles at a maximum depth of nearly 7200 feet. Considerable bathymetric data has been gathered on this portion of the submarine cable route, and is available for review in the public document room (see Appendix B, Section B.2.2.1 and Figure 3.6D).

Depending on the type of oil-filled cable proposed, pressurized or non-pressurized, a landing on Maui may not be necessary for technical reasons. Note, however, that the base system requires the PROPOSER to cost out in-and-out terminations on Maui. If necessary, a converter terminal could be located near the south shore and the HVDC cables brought in and taken out at the same site.

The second segment of submarine cable would follow the Alalakeiki, Auau, and Kalohi channels between Maui, Kahoolawe and Lanai past Molokai, crossing the Kaiwi Channel to Oahu. The landing on Oahu, as mentioned earlier, would likely be in the vicinity of Waimanalo on the windward or eastern shore of Oahu. This submarine cable length is about 96 miles, with a maximum depth less than 2400 feet.

3.6.2.4 Cable Transition Stations

Transition stations will be necessary wherever the electric power transmission changes from overhead line to submarine cable or vice versa. Depending on the exact overhead route taken for the base system, the line could exit the island of Hawaii somewhere on the North Kohala shore, possibly near Muhakona Harbor. A transition station would, therefore, be necessary on Hawaii before the submarine crossing to Maui. For the option of a submarine cable around Hawaii, a transition and pressurizing station in and out may be needed on Hawaii, possibly near Waipio, if a pressurized cable design is used.

Two transition stations on Maui would be required for the base system where the HVDC line will cross Maui overhead. Even if it is unnecessary to land on Maui, the PROPOSER must cost out the base system for evaluation purposes.

A separate transition station should not be necessary on Oahu since the converter terminal should be within a few miles of the submarine cable landing.

3.6.3 RATINGS AND CAPABILITIES OF CONVERTERS AND LINES

Exact ratings of the geothermal HVDC transmission system are the PROPOSER'S decision, and will be a function of negotiation between HECO and the DEVELOPER. The following ratings and load capabilities for normal and emergency operation are provided to illustrate what is perceived by HECO to be necessary to meet HECO's primary goal of being able to purchase 500 MW of firm geothermal power meeting the reliability criteria of Chapter 4.

PRELIMINARY EQUIPMENT AND LINE RATINGS (PER POLE)

	Rating (MW)		Voltage	Current (Amp)	
Description	Normal	Emergency	(kV)	Normal	Emergency
Converter	250	500, 1-2 sec. 375, continuous	± 300	833	1250
Overhead Line	250	375/pole	± 300	833	1250
Submarine Cable	250	375/pole*	± 300	833	1250*

* (The cable can be specified with no significant emergency overload rating only if a third cable is installed when the geothermal power exceeds 250 MW. If the PROPOSER'S intention is to use only two cables, each must be able to carry 375 MW

continuously. See Section 3.6.6.4 for a discussion of the required switching capability.)

It should be emphasized that the use of 125, 250 and 375 MW for intermediate power levels and a transmission voltage of ± 300 kV are illustrative only and should not be regarded as fixed or final values even for the response to the RFP. The Proposal schedule (Exhibit 5.3A) for reaching 500 MW of capability by 2005 for all production and delivery elements is the responsibility of the PROPOSER.

3.6.3.1 Operating Requirements

While specific HVDC voltage and power ratings have been mentioned in this description of the HVDC transmission system, it is incumbent on the DEVELOPER to select the actual system voltage and power transfer capabilities. The ratings proposed in this specification should be used in responding to the RFP. However, options may be included for other levels which in the PROPOSER'S opinion may improve reliability, operating flexibility, or economics.

For the Project, power is defined as the AC power measured at Aniani Substation on HECO's 138 kV system.

Voltage for the Project is defined as the AC voltage measured at Aniani Substation on the HECO system.

When a power or voltage rating is a requirement, the power and voltage rating will be considered in compliance when they exist:

- over the complete range of ambient or atmospheric conditions described;

- with AC voltage and frequency within limits as given in Section 3.7.2.1

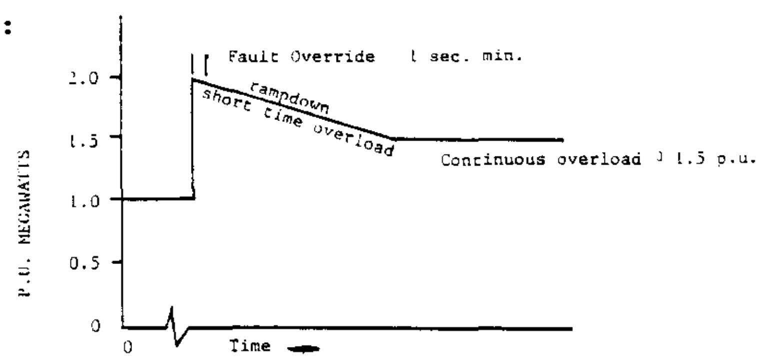
- with converter firing and extinction angles inside steady state ranges; and

- when not using equipment, lines, or cables intended as spares.

The two poles for the Puna and Waimanalo converters should be designed so they are independent with separate control systems and dispatching capabilities to allow maximum flexibility in integrating the geothermal output into the HECO system. See Section 3.8 for specific interface requirements.

3.6.3.2 Emergency Overload Requirements

The HVDC converter system emergency overload requirements are dictated by HECO spinning reserve and quick load pick-up time limits. The overload rating defines the capability which must be provided on a continuous basis to meet operational contingencies, but which is not expected to be used under the majority of situations. As mentioned, the HVDC system must be designed so that the maximum load reduction for loss of either pole component, overhead line structure or cable does not result in a power loss greater than about 125 MW. Assuming a phasing of available power at Aniani Substation as discussed in Section 3.6.4.1, an overload capability for each converter pole similar to that shown below will be necessary:



The PROPOSER should define and quantify the overload capability of all major components in the HVDC transmission system including, but not limited to, the following:

- Puna converter terminal
- Overhead transmission lines
- Submarine transmission cables
- Cable terminations
- Waimanalo converter terminal

See Section 3.8 for specific interface requirements.

3.6.4 CONVERTER TERMINALS

The following are general comments concerning the configuration and operating modes of the HVDC system:

The Puna and Waimanalo converters should be full bipoles with two, six-pulse bridges connected in series on each pole, which will make it easier to schedule installation of the DC system to match the development of the geothermal resource.

The Puna converter will operate as a rectifier and the Oahu converter as an inverter. Under these configurations power transfer will always be from Hawaii to Oahu (500 MW).

3.6.4.1 Operating Modes

Possible operating modes for the HVDC system include:

Balanced Bipolar
Unbalanced Bipolar
Monopolar Sea Return

One possibility for the sequence of construction, operating modes and approximate MW and voltage ratings for the Hawaii and Oahu converters is as follows:

Phase I	-	125 MW, + 150 kV, monopolar
Phase II	-	250 MW, ± 150 kV, bipolar
Phase III	-	375 MW, + 300 kV, -150 kV bipolar
Phase IV	-	500 MW, ± 300 kV, bipolar

While the DEVELOPER has some flexibility in scheduling the geothermal power development, the above sequence is primarily driven by HECO's spinning reserve and reliability requirements as discussed in Chapter 4 and power requirements, as outlined in Section 5.1. The schedule submitted on Exhibit 5.3A should include the converter configuration.

3.6.4.2 Equipment Data and Information

The details of equipment design and final ratings are the responsibility of the DEVELOPER subject to HECO evaluation as deemed necessary to meet the HECO power requirements and reliability as set forth in this RFP. For the converter terminal, the PROPOSER should supply design data and information according to the following list for evaluation purposes:

- DC system one-line diagram
- Converter terminal layout drawings
- Converter terminal plan and elevation drawings
- Converter transformers
- AC filters
- AC reactive supply
- Valve hall layout
- Valve design details and single line diagram to the thyristor level

- Valve control system (effect of cable)
- Valve cooling system
- All surge arresters, AC and DC
- Smoothing reactors
- DC filters
- Neutral bus arrangement
- Neutral grounding system

In addition, the PROPOSER should submit sufficient information to verify that the proposed converter terminal designs meet the power transfer and voltage requirements set forth in this RFP. This information includes:

- For each converter terminal:
  - Transformer impedance
  - Rated no-load voltage, U_{don}
  - Nominal firing angle
  - Nominal extincition angle
  - Converter equation
  - Steady-state range of firing angles
  - Steady-state range of extinction angles
  - Maximum no-load voltage (U_{do} maximum)
  - Minimum no-load voltage (U_{do} minimum) and related system operation condition
  - Maximum pole-to-neutral voltage
  - Maximum pole-to-ground DC voltage
  - Minimum pole-to-neutral DC voltage and related system operating condition
  - Transformer load tap changer percent range and number of steps

- Illustrative examples of system power transfer condition, associated system voltage profiles and converter terminal conditions. Those system operating configurations, operating modes and system power level dispatches which dictate load tap changer ranges and/or converter angle operating ranges shall be included.

- Converter terminal and DC system reduced voltage capabilities and associated DC current capabilities.

- Information on the voltage ranges which may be expected at the converter terminals during minimum current operation.

3.6.4.3 <u>AC and DC Harmonics and Harmonic Filters</u>

The design and performance of both AC and DC harmonic filters is the responsibility of the DEVELOPER. The general criteria set forth herein are estimates of minimum levels which should be met in order to assure HECO that there will be no harmonics introduced either into the AC systems at converter terminals or from coupling into AC circuits or other electrical facilities along the route of the HVDC transmission system.

a. <u>AC Harmonic Filters</u>

The DEVELOPER shall furnish AC harmonic filters, segregated with one set of filters per converter pole bus. The AC filters shall perform properly when taking into account the combined effects of:

- Harmonic current generation from the converters and static compensators (if used) at the converter terminal,

- Induced 60 Hz effects from any parallel AC lines,

- Electrical and environmental conditions as described in Section 3.7.

Because of the impact on the HECO AC system of harmonic generation by the converter, the DEVELOPER will be required to minimize the effect by proper design of the AC filters. The PROPOSER should provide sufficient information from study results modeling both the HECO AC system and the proposed HVDC transmission system to demonstrate that the PROPOSER has a thorough understanding of all factors which contribute to harmonic interference.

The PROPOSER should include discussions of the following areas in the Proposal:

- Definition of normal and contingency ratings
- Assumptions for harmonic generation
- Imbalance considerations
- Simulation or equations used in calculating generated AC harmonic currents
- Filter detuning
- Effect of loss of one filter on the calculation

The estimated AC harmonic performance criteria are as follows:

	Normal Operation	Contingency Operation
Individual Distortion	1.0 percent	1.5 percent
Total Distortion	2.0 percent	3.0 percent
Telephone Interference Factor	35	50
I_{eq} (mA-RMS)	400	400

b. DC Harmonic Filters

The PROPOSER should adopt a comprehensive system-level design approach to determine the final DC harmonic filter requirements for all of the HVDC system converter terminals. The primary design criterion shall be based on limiting interference to voice-frequency communication circuits which may be located adjacent to the DC transmission line.

Design of the DC harmonic filters shall take into account the combined effects of:

- All modes of operation for all possible DC system operating configurations.
- Induced 60 Hz effects from any parallel AC lines. The effects on harmonic generation or propagation of any special equipment included in the Proposal to deal with this issue shall also be considered, such as 60 Hz filters or specific control strategies.
- The electrical and environmental conditions described in Section 3.7.

The PROPOSER should provide sufficient information from study results to demonstrate that the PROPOSER has a proper understanding of all factors and has performed the studies necessary to support the proposed design of the DC harmonic filters for the Project's converter terminals. The PROPOSER is solely responsible for determining the DC system operating configurations which establish the worst-case conditions for design of the DC filters.

To allow proper evaluation of the DC filter designs and their performance, the PROPOSER will also provide the following information in the Proposal:

- Description of DC filter performance
- Evaluation method (Calculation of equivalent disturbing current, Iq)
- DC system modeling
- Harmonic generation assumptions
- Filter detuning assumptions
- Calculation results in tabular form

The DC filter designs, when the system is in bipolar operation, should result in an Iq equal to or less than 200 mA rms anywhere along the DC transmission line. When in monopolar operation, the system is not required to meet this value, however, the PROPOSER should calculate and present the results for monopolar operation of the system.

3.6.4.4 Reactive Compensation and Voltage Control

The DEVELOPER shall furnish all necessary reactive compensation and voltage control equipment for the Waimanalo converter terminal based on requirements of this RFP. The subject equipment may include any combination of AC harmonic filters, shunt capacitors, shunt reactors, static var compensators and/or synchronous condensers. The PROPOSER is not restricted to this list.

The reactive compensation equipment should also include all necessary circuit breakers, switches, isolators, protection and measurement/control devices.

The reactive compensation equipment should be an optimal combination of components and controls that will satisfy the reactive needs of the DC converters and the HECO AC system while considering installed costs, filter requirements, and the power delivered to the HECO system.

a. Steady State Reactive Requirements of the HECO AC System

The reactive requirements of the HECO system are a function of the AC load level and operating conditions and the level of HVDC system power transfer. For the purposes of the response to the RFP, the PROPOSER should assume that by 2005 the HECO system will require an additional VAR supply of 310 MVAR at a nominal voltage of 138 kV, which corresponds to the MVAR capability of a 500 MW conventional power source operating at 85% leading power factor. While the final AC system design may require the 310 MVAR to be split into smaller banks and located at other substations on the HECO system, the PROPOSER should assume the AC system VARS will be located at the Waimanalo Converter Terminal and installed by the DEVELOPER.

A voltage support study of the 138 kV system will be performed by HECO. The results will be available to the DEVELOPER for final design purposes.

b. <u>Reactive Demand of the Converter Terminals</u>

The DEVELOPER is responsible for providing at a minimum sufficient reactive supply to compensate the converters reactive requirements to unity power factor across the total power output range of the converter terminal. The PROPOSER should state the minimum power level (monopolar) in the Proposal design and discuss how it was determined.

c. <u>Steady State and Transient Voltage Control</u>

The reactive compensation system elements should be used for steady-state AC voltage control. An automatic AC voltage control function should be provided which will receive operator unit input settings which will maintain voltage between the limits shown in Section 3.7.2.1.

The DEVELOPER should provide automatic controls for switching and/or otherwise controlling the reactive compensation so as to maintain the steady-state voltage at the Aniani Substation 138 kV bus within an adjustable bandwidth.

Normally, the voltage will be maintained within the range 1.01 per unit (p.u.) to 1.04 p.u. through automatic control.

This should be achievable, for example, by operator selection of 1.01 p.u. as the lower limit and by selecting an appropriate bandwidth.

To minimize voltage flicker, the transient change in the fundamental frequency component of voltage on the Aniani Substation 138 kV bus should not exceed 1 percent (.01 p.u.) for more than 1-1/2 cycles when a shunt capacitor, harmonic filter bank or shunt reactor bank is switched.

The above requirement should apply at all relevant DC system power transfer levels and the normal short-circuit capacity level as defined in Section 3.7.2.2. This requirement should also be satisfied when any one of the HECO 138 kV lines terminating at Aniani Substation is out of service.

The MVAR rating of all switchable capacitor banks and AC harmonic filter banks should be limited, as required, to be consistent with voltage drop requirements as stated. The PROPOSER should specify the appropriate switching equipment.

All circuit breakers or load break switches used for switching capacitors and filters should be capable of disconnection or energization of any bank, with the other banks energized without restriction. There should be no limitation on the energization of any shunt bank by reason of temperature, frequency, or AC bus voltage within the range applicable for valve group operation.

d. PROPOSER Requirements

The PROPOSER should describe his complete philosophy on reactive compensation and voltage control including discussion on the following subjects:

- Reactive compensation and voltage control studies
- Load flow studies
- Dynamic simulation studies
- Reactive compensation system design
- One-line diagram of reactive compensation scheme with all equipment identified
- Calculation of reactive requirements
- Reactive absorption requirements, if any, and equipment or control strategy used to satisfy requirements
- How steady-state voltage will be achieved
- Minimizing voltage flicker when switching
- Availability and contingency philosophy

3.6.4.5 Insulation Coordination

The insulation coordination of a HVDC converter terminal is critical to the reliability and cost of the terminal, more so than in an AC substation. The PROPOSER is expected to complete a preliminary insulation coordination study for the AC switchyard (including the AC side of the inverter transformer), the thyristor valves and the DC switchyard. The study should result in determination, on a preliminary basis, of insulation withstand values for all voltage levels, surge arrester protective levels, protective margins, arrester ratings, arrester dimensioning, and energy discharge requirements.

The study can utilize digital computers or a combination of digital and analog simulators if desired. Basic assumptions used in the study should be discussed and included in the Proposal.

The AC and DC system events which produce overvoltage deemed critical by the PROPOSER and on which his insulation coordination is based should be discussed and a rationale included for evaluation purposes. System events which should be considered in the determination of the critical events should include, but are not limited to, the following:

- HECO AC system faults
- Load rejection
- Converter terminal AC faults
- Valve hall faults
- DC switchyard faults
- Control malfunctions
- DC line faults
- Switching surges
- Lightning surges
- Dynamic overvoltages

A summary of the results of the insulation coordination should be included with the Proposal, preferably in tabular form.

3.6.4.6 HVDC System Studies and Testing

The DEVELOPER shall perform, during the detailed design phase, steady-state studies of the DC system in sufficient detail to ensure that all of the requirements for system power transfer and voltage set forth in this RFP have been met. The study results must be approved by HECO before release of equipment for manufacture. A description of these tests and where they will be performed should be included in the Proposal. The PROPOSER shall also describe in the Proposal a series of verification tests which will be performed after the above design tests are completed. The facilities to be used for the verification tests should also be described in full detail. The verification tests should include, but not be limited to, the following areas:

Steady state control performance
Transient control performance
Stability
Insulation coordination
Harmonic filters
Reactive compensation

3.6.5 OVERHEAD HVDC TRANSMISSION LINES

This RFP has identified two line segments using HVDC overhead transmission in the base plan. The first is across Hawaii and the second across the southern end of Maui. The PROPOSER is requested to treat these overhead line segments in the base system as required, regardless of whether the preferred approach is the same as the base system or not. Modifications to the base system may be included as options.

The PROPOSER is free to design the overhead line structure and conductor configuration as desired, as long as they are in compliance with the NESC and State of Hawaii General Order No. 6. To be consistent with HECO system requirements presented in Section 3.6.3, each pole conductor of the overhead line sections must be capable of carrying 375 MW in the event of the loss of the conductor for the other pole. For the base proposal, the assumptions presented in Sections 3.6.3 and 3.6.4.1 should be followed by the PROPOSER in designing and dimensioning the HVDC overhead line sections.

3.6.5.1 Structural Design Guidelines

The HVDC transmission structures for the ± 300 kV line can be wood pole, steel pole, lattice self-supporting or guyed lattice. The bipole line could use two monopole structures or a single bipole structure. The decision as to which of these structure types or configurations is used is a function of economics, reliability, and schedule requirements, which the PROPOSER should consider in responding to this RFP. Meteorological and atmospheric data for Oahu, Hawaii and Maui is given in Section 3.7.1 and can be used for preliminary criteria for both structural and electrical design as needed.

- The structural design should utilize loading criteria for the state of Hawaii and in particular the islands of Hawaii and Maui. The information below is presented for reference only:

  NESC light loading district
  NESC extreme wind load of 145 fps
  Maximum wind speed of 88 fps
  Seismic Zone 3

- Preliminary sketches showing conceptual structural aspects of the major tower types should be included with the Proposal. These sketches should include all pertinent dimensions, such as tower height, width at base, crossarm width, shield wire height above crossarm, crossarm height above ground and loading capability.

- Design criteria used in developing the tower types and dimensions and foundations should be stated in the Proposal.

- Some data on soils along the preliminary routes is available in the public document room. The DEVELOPER must obtain actual data through soil borings and land surveys for final design purposes.

3.6.5.2 Electrical Design Guidelines

The electrical design aspects of the HVDC ± 300 kV overhead transmission line include conductor selection, insulator selection, clearances, shielding, grounding, corona, field effects and free ion movement. With the exception of ion drift there is little, if any, difference between AC and DC transmission lines in terms of design criteria, either structurally or electrically.

Conductor selection should include consideration of the HVDC conductor thermal limits based on ambient air temperature and corona level. Requirements on overload capability are detailed in Section 3.6.4.3 and ambient temperature ranges are presented in Section 3.7.1. If the overhead line route selected by the PROPOSER is through the saddle between Mauna Loa and Mauna Kea on the island of Hawaii, consideration should be given to the high altitudes (above 6000 feet) and their effect on corona start voltage.

Insulator selection, both number per pole and contour should be carefully analyzed by the PROPOSER. Salt contamination is severe in some locations where overhead lines could be routed. The experience with AC in those same areas has required not only fog type insulator units with higher leakage than conventional units, but sometimes more units per string. The PROPOSER should consider all reasonable possibilities for improving insulator performance over routine design, including the use of vee string configuration, special DC ceramic insulators and polymer non-ceramic units. The PROPOSER must provide complete details on the insulator selection process and tests to be performed by the DEVELOPER to verify insulator selection and performance.

Clearance, shielding and grounding design are essential elements to consider in order to obtain adequate lightning performance and to meet NESC and State of Hawaii requirements for safety. The PROPOSER should include with the Proposal all design criteria and calculations involving comparisons to NESC and State requirements, including predicted outage rates per 100 miles per year for the transmission line design proposed.

Corona effects are related to conductor size, span length, and clearances to grounded objects. The PROPOSER should include in his response a discussion of the levels of corona and its direct effects on radio noise, television interference and audible noise expected with his design. A discussion of the calculation methods and assumptions utilized should be included. Data should be given at nominal voltage and at ten percent above nominal voltage.

Electric and magnetic field effects under and near HVDC transmission lines are essentially the same as produced under AC lines except for the lack of a time varying electromagnetic field. Thus, electric fields under or near DC lines cannot produce current flow in objects under or near the lines. The PROPOSER should provide electric and magnetic field profiles for the proposed line design under the line and to the edge of the right-of-way. Any interaction effect from other electric power lines on the same right-of-way should be included in the results.

Free ion movement in the vicinity of HVDC lines is not known to create a hazard to human or animal health, however, the PROPOSER should include a discussion of the subject as a function of his HVDC line design.

3.6.6 SUBMARINE CABLE

Submarine cables have been researched and the results are documented and part of the data available to the PROPOSER.

The research program covered the following subjects in detail:

Cable Design Criteria	Cable Design Parametric Studies
Route Identification	Economics
At-sea Route Surveys	Manufacturing and Transport
Bathymetric Surveys	Cable Laying and Retrieval
Environmental Survey	Vessels

Sediment, Wave Motion and Ocean Current Measurements	Laboratory Test Protocol At-sea Test Protocol

The cable research results are summarized below. HECO does not represent that this information is a complete summarization of all existing documents. The summary is provided only for the PROPOSER'S information.

- Based on presently available information, there appear to be cable designs which satisfy the defined system requirements and environmental conditions which affect deployment, retrieval and repair of a commercial cable for this Project.

- Technical feasibility appears achievable by the application of existing state-of-the-art design for conventional self-contained submarine cables, either pressurized or non-pressurized.

- Extensive surveys of the sea environment have been conducted to determine the details of the bottom on one cable route, velocities of the currents in the Alenuihaha Channel from the surface to the bottom, wind velocities and wave heights. A procedure for testing a candidate cable was developed, incorporating both CIGRE tests and tests reflecting the specific conditions found on this cable route. As a result of these tests, the reports summarized have concluded that it is feasible to design, manufacture, and install a cable that can withstand the mechanical loads resulting from installation and operation for a thirty years life under the environmental conditions examined. The reports describing the tests, test procedures and results are listed among the references for this RFP. A report on at-sea test results with a surrogate cable is expected to be available by March, 1990.

- Cable designs using aluminum conductors are available that accommodate reasonable ranges of external and internal mechanical stresses and fulfill the Project's electrical requirements.

- The technical data and information available permits assessment of reliability, manufacturing feasibility, design requirements for installation and recovery vessels, design of cable handling equipment, costs and fabrication schedule.

Selection of the cable type or types is the PROPOSER'S responsibility. The PROPOSER should describe fully the philosophy and rationale involved in the cable selection process. In addition, each of the cable mechanical and electrical design parameters described briefly in the following section should be included in the Proposal. A more detailed treatment of these parameters may be found in the cable design parametric study for the Hawaii Deep Water Cable research program, Call No. 119 of the Bibliography. The PROPOSER should indicate how it will be demonstrated that the proposed cable design(s) can withstand the mechanical and electrical loads defined in the Laboratory Test Protocol, Call No. 118 of the Bibliography.

3.6.6.1 Basic System Criteria

For the purposes of this RFP, the following system criteria should be considered for the base Proposal.

Transmission configuration	Monopolar to full bipole (See Sections 3.6.3 and 3.6.4.1)

Number of cables	Two or three (one spare)
Cable voltage rating	Final ± 300 kV DC
Load capability (per cable)	Two cables 375 MW each or if three cables 250 MW each
Overvoltage (transient)	PROPOSER responsibility
Overvoltage (steady state)	PROPOSER responsibility
Polarity reversal	PROPOSER responsibility

There are a number of physical and topographical design criteria, some of which are specified as part of the base bid and others which are the PROPOSER'S responsibility. These are:

- Minimum spacing between cables	PROPOSER Responsiblity
- Number of cable splices and termination	PROPOSER Responsiblity
- Continuous length of cable	42 miles and 96 miles
- Maximum water depth	7200 ft

Possible cable routes for this RFP, including the option around Hawaii, are described in Section 3.6.2.4. Bathymetric studies have been completed for the route from Hawaii to Maui across the Alenuihaha Channel and between Maui (Ahihi) and Oahu. These studies are available for review in the public document room. Depths for the Alenuihaha Channel from Hawaii to Maui are shown in Figure 3.6F.

The optional cable route around the island of Hawaii to Kohala has not been studied in detail, nor has the area around La Perouse Bay on the Maui southwest shore. The latter appears to have two potential problems; first, the sea bottom may be both rough and unstable, and the cable may require burial to avoid damage, and second, the area is part of the Ahihi-Kinau Natural Area Reserve, which extends out some distance from the shore.

Surface and subsurface conditions which affect cable performance and ratings are external parameters which should be considered and quantified for verification purposes. These include the maximum surface water temperature, the seabed ambient temperature, the seabed thermal resistivity, the depth of sedimentation coverage, the seabed profile, and the subsurface currents.

Information on these parameters may be found in the Bibliography. They should be considered when calculating the average conductor resistance for evaluating the cable losses at rated current and for conducting the necessary hydraulic analyses for design purposes. The loss calculation result should be provided in average loss per unit length (kW/ft).

3.6.6.2 Cable Design Parameters

The cable design parameters listed below are for reference only and are not all-inclusive. The PROPOSER should describe the cable or cables intended for use in the base Proposal using cable lengths and designs which reflect the basic system criteria in Section 3.6.6.1, and provide values for each of the cable design parameters listed.

Basic cable design parameters to describe the cable system proposed include:

- Cable type or types
- Conductor material
- Conductor design
- Conductor size in sq. mm and cir. mils.
- Oil duct size (if needed)

- Major insulation materials
- Dielectric fluid
- Sheath materials
- Armor design
- Maximum allowable electrical stress
- Maximum allowable temperature of conductor
- Maximum allowable temperature differential between conductor and ambient for three sea locations using the given ambient temperatures for reference and Proposal purposes only:

Sea location	Ambient °C	°F
Deep (>2000 ft)	3	37
Intermediate (200 - 2000 ft)	14	57
Near Shore (100 - 200 ft)	25	77

The PROPOSER should provide a detailed description of the cable type or types based on the elements of the cable construction identified in the following list. A cross-sectional graphic presentation of the cable should be included, with each element identified and element thickness specified.

Conductor	Sheath
Conductor shield	Jacket tapes
Insulation	Bedding, binding and serving
Insulation shield	Armor

Core protection Corrosion protection

3.6.6.3 Design Constraints

There are thermal, electrical, and mechanical constraints inherent in the selection of submarine cable which must be carefully considered at the design stage, particularly if there is any deviation from accepted practice. Both electrical and mechanical design safety factors should be discussed and tabulated in the Proposal. The PROPOSER should discuss each of the constraints listed below and describe how, in the proposed design or designs, each has been accommodated:

a. Thermal constraints

- Maximum allowable conductor temperature
- Maximum allowable temperature differential

b. Electrical constraints

- DC voltage stress
- Transient overvoltage
- Steady state overvoltage
- Polarity reversal
- Polarity reversal followed by overvoltage
- Impulse strength

c. Mechanical constraints

- Water pressure at depths expected to be encountered in this project
- Crushing load during installation
- Thermal cycling effects on sheath integrity

- Deployment and retrieval tensions
- Distribution of pulling tensions
- Maximum allowable pulling tensions
- Maximum allowable cable elongation during installation and retrieval
- Minimum cable bending diameter

d. Miscellaneous constraints

- Hydraulic pressure (pressurized cables only)
- Cable length
- Sea bottom profile
- Slope

3.6.6.4 Switching, Splicing, Termination and Auxiliaries

The PROPOSER should include a detailed description of splicing techniques and termination design to be used, particularly if different types of cable are to be spliced anywhere on the route. A conceptual layout of the submarine cable route should be included in the Proposal showing splice locations, termination stations, pressurizing stations, sectionalizing stations and switches for rapid transfer to the spare cable in case of a cable fault.

Switching

If the overload capability and reliability required for the submarine cable when at the maximum capacity of 500 MW is met by use of three cables, the DEVELOPER must include means of quickly switching out a faulty cable to minimize time at reduced power. The PROPOSER should show a single line diagram of the switching scheme, the type of switches to be used, and an estimate of the time required to isolate a faulted cable and restore full power.

A rationale for switching scheme, including configuration for the three cables should be provided.

3.6.6.5 Manufacturing, Transport and Installation

Although the projected diameter of the cable is not unusual, the length and depth of the route may pose significant challenges in transport and installation. It appears that the manufacturing capability without splices, and the shipping length with minimum splices, may be critical elements in accomplishing the successful installation and operation of the cable. The PROPOSER should present a complete description of the following:

- Manufacturing capability including maximum cable length and feet/month possible by the proposed manufacturing facilities.
- Location of the cable manufacturing facilities.
- Shipping capability; i.e., length of cable on storage turntable, and number of splices per shipping length.
- Cable installation plan including transport, identification of transport and installation vessels, and proposed schedule for cable installation.
- Cable retrieval and repair procedure.

3.6.7 HVDC NEUTRAL GROUNDING SYSTEM

The HVDC transmission system will require neutral grounding at Puna and Waimanalo, and possibly at Maui. The ground return system can be designed in several ways: as an embedded ground electrode; as a sea electrode, either on shore or a short distance off shore; or as a dedicated metallic conductor on the pole line structure for overhead lines and using a separate cable for submarine sections.

For a three cable system, the ground return system for the Puna and Waimanalo converters must be capable of carrying 833-1250 amperes continuously since the system will likely operate in the monopolar configuration in the initial phase. In the third phase (See Section 3.6.4.1), the system may operate in an unbalanced bipolar mode, again resulting in significant current in the neutral. In a balanced bipolar system, the maximum normal neutral current is only one or two percent of the pole current or 10 to 25 amperes. The neutral will only carry full load current during temporary monopolar operating conditions.

The PROPOSER should consider all types of ground return designs and decide which should be employed at each converter for the base Proposal. The following information may be used for guidance; however, the DEVELOPER is responsible for obtaining detailed local data for ground return design.

3.6.7.1 Ground Electrodes

Ground electrodes are most efficient and cost effective when the earth resistivity in the vicinity of the converter is 150 ohm-meters or less. The earth resistivity on Oahu near Waimanalo is estimated to be about that level, although no measurements have been taken recently. The PROPOSER must consider interference effects on nearby electrical facilities and pipelines if a ground electrode is planned, and discuss proposed mitigating measures and procedures. A layout of any proposed ground electrode, with dimensions, should be included in the Proposal, bearing in mind that the ground electrode should be at least 2.5-3.0 miles from the converter terminal.

The earth resistivity of the KERZ is very high, above 2000 to 3000 ohm-meters. This high resistivity probably means that a ground electrode cannot be used because of severe cost penalties and interference problems.

3.6.7.2 Sea Electrode

An alternative to the ground electrode is the sea electrode, if access to the sea is available within a reasonable distance from the converter. A sea electrode can be constructed either at the shoreline or a short distance off-shore. The converter is likely to be only a short distance from the sea for each location for the Project. There may be a problem at Waimanalo in obtaining sufficient separation between the converter and the sea electrode to avoid interference. If the PROPOSER selects a sea electrode for this application, a conceptual design sketch and layout should be included with the Proposal. While a sea electrode may have some distinct advantages over a ground electrode, precautions may need to be taken to protect fish and sea life in the area and to avoid siting the facility near a public beach or recreational area for safety and aesthetic reasons.

3.6.7.3 Metallic Return

A metallic return involves adding a fourth cable to the HVDC submarine segments of the transmission line and a third conductor to the overhead portions. It also means starting initially with two cables rather than the one which would be possible with either a ground or sea electrode system. The cost of using a metallic return may be too high to compete with the other options; however, this decision is the PROPOSER'S choice and responsibility.

3.6.8 HVDC SYSTEM CONTROL AND PROTECTION

The operation, control and protection of the HVDC system is the responsibility of the DEVELOPER. However, to ensure that the HVDC system will operate properly with HECO's system, HECO desires that the HVDC system control and protection be designed with the following primary considerations.

- The control and protection system should be flexible to allow adjustments and modifications to control and protection strategies as both DC and AC system operating needs change.

- Control and protection strategies should be secure, with minimum false operations. Schemes to protect equipment should be fail-safe, and should rely only on locally measured quantities. Remote signals may be used to improve selectivity and sensitivity of protective actions and recovery from faults, but should not be required to complete or initiate protection of equipment.

- Control and protection strategies should be consistent among all converter terminals, wherever possible.

- The control and protection system should be as simple as possible, while meeting all functional requirements.

- All equipment should be self-protected within each converter terminal.

The PROPOSER must explain the hierarchy of the control system proposed and relate it to the overall system operation identified in the Proposal, consistent with HECO reliability requirements.

The PROPOSER should identify all HVDC control system communication requirements and list those which will have to be integrated into the HECO communication and dispatch network and those which will be only used in the DEVELOPER'S system.

In addition, for evaluation purposes, the PROPOSER should discuss the following features of the control system proposed:

- available control modes
- automatic or manually controlled equipment, such as filters and capacitor banks
- polarity reversal
- converter transformer tap changers
- coordination between terminals
- command orders between terminals
- special contingency control, such as runback schemes
- subsynchronous resonance (torsional interaction)

a. <u>AC-Side Protection</u>

The DEVELOPER shall provide adequate protection for all converter terminal equipment, and shall ensure that protection is properly coordinated with HECO's protection scheme at Aniani Substation.

Protective actions that result in tripping a converter pole AC-side circuit breaker must be coordinated with a scheme to also separate that converter pole from the DC system with minimum disruption to the power flow in case other terminals are added to the DC system.

The Proposal should fully describe the AC-side protection.

b. DC-Side Protection

Protective systems must be able to distinguish between transmission line and converter faults, and must quickly isolate faults in such a way that the least amount of power being transmitted by the DC system is interrupted.

The PROPOSER should fully describe the DC-side protection systems. Converter protection, line protection and auxiliary protection systems shall all be described for each anticipated DC system operating configuration and mode, both with communication systems in service and out of service.

3.6.9 HVDC TRANSMISSION COMMUNICATION AND TELECONTROL

The DEVELOPER will provide and operate a communication system which will transmit the telecontrol information required for safe and reliable operation of the HVDC system. This communication system can be either microwave or fiberoptic submarine and overhead cable.

The PROPOSER should describe the communication and telecontrol system in detail for evaluation purposes, including, but not limited to, the following:

- Functional diagram of the control and communication system between terminals

- Block diagram of the telecontrol system illustrating segregation of bipole, pole and valve level functions

- Telecontrol signal

- Telecontrol system design

- Signal security and redundancy
- Equipment and configuration

3.6.10 PROPOSAL REQUIREMENTS

3.6.10.1 Base Proposal

The base HVDC transmission system includes these components and locations:

- A converter station in the Puna area of Hawaii.
- An overhead ± 300 kV bipolar line from the Puna converter terminal to the North Kohala area, either through the saddle between Mauna Loa and Mauna Kea or along the Hamakua Coast (131 miles).
- A ± 300 kV submarine cable from Hawaii to Maui (42 miles).
- A ± 300 kV overhead line across Maui (20 miles).
- A ± 300 kV submarine cable from Maui to Oahu (96 miles).
- A 500 MW converter terminal on Oahu near Waimanalo.
- Depending on PROPOSER'S choice of location of the converter terminals on Hawaii and Oahu, there could be short sections of ± 300 kV underground cable or overhead line between the shore and the converter terminal or a double circuit 138 kV line between the output of the Oahu converter terminal and the Aniani Substation.

3.6.10.2 Options

At the discretion of the PROPOSER, one or more of the following options may be included in the Proposal. A response to the base Proposal must be supplied before including an option.

- Replace the overhead line across Hawaii with a submarine cable exiting Hawaii near Honolulu Landing on the eastern shore, southeast of Hilo. The cable can either go directly to Maui or land near Waipio Bay for re-pressurizing or switching purposes, and then cross the Alenuihaha Channel to Maui.

- The PROPOSER can exclude the landing on Maui or land and exit at the same site if there are technical reasons for a landing. The latter approach would, of course, allow a tap on Maui at some future date.

3.7 EXISTING AC SYSTEM CHARACTERISTICS

This section contains information on the HECO system that the PROPOSER may use as necessary for Project conceptual design and in modeling the utility/Project combined system for control system analysis.

Complete electric data is included only for Oahu (HECO), since neither the power production facility AC collector system feeding the Puna converter nor the HVDC system from the converter will be interconnected with the Hawaii Electric Light Company network as part of this Project. Transmission line design and insulation practices are included for all islands since it is assumed the PROPOSER will use HECO principles and practices in the design and costing of the AC transmission system.

3.7.1 METEOROLOGICAL AND ATMOSPHERIC CONDITIONS

Meteorological and atmospheric conditions for Hawaii, Maui and Oahu are presented in Table 3.7A since facilities could be constructed on each of the islands. The data and descriptions given in Table 3.7A can be used for RFP responses if desired. The PROPOSER and DEVELOPER are, however, responsible for researching and developing their own geographic and atmospheric data base. Data for evaluation purposes is provided for the locations and routes described in this RFP.

3.7.2 ELECTRICAL AND SYSTEM DATA

The first phase of Project power is scheduled for delivery to HECO early in 1995. The electrical and system data provided in this subsection are applicable to 1995 and may be used by the PROPOSER. The following data is, however, preliminary and the DEVELOPER will be responsible for verifying all the data used in the design calculations.

3.7.2.1 System Operating Parameters

a. Voltage - kv (deviation)	HECO
- Nominal phase-to-phase	138
- Normal minimum phase-to-phase	136.1
- Normal maximum phase-to-phase	143.6
- Emergency minimum phase-to-phase	126.5
- Emergency maximum phase-to-phase	145
- Normal negative sequence	2%
- Maximum phase unbalance	2%

b. Frequency - Hz (deviation limit)	HECO
- Normal base	60
- Normal minimum	59.95
- Normal maximum	60.05
- Emergency minimum	58.5 (10s)
- Emergency maximum	61.5 (20s)

c. Load Shedding Schedule

Minimum frequency - 57 Hz

Blk	Freq (Hz)	Time (s)	MVA (day)	MVA (eve)
I	58.5	5	43	41
1S	58.0	0	82	101
2S	57.7	0	114	143
3S	57.4	0	44	120

d. Load Restoration Schedule

Blk	Freq (Hz)	Time (s)	MVA (day)	MVA (eve)
1R	59.9	*	27.7	27.7
2R	59.8	*	75.8	75.8
3R	59.7	*	125.9	125.9
4R	59.4	*	93.9	93.9

* Time varies between 6 and 42 seconds.

e. Maximum Phase Unbalance

∿2 percent

3.7.2.2 System Study Data

This subsection contains HECO system data, including short circuit capability, system impedance, load flows and machine data which may be used by the PROPOSER for preliminary system studies, converter control design and equipment ratings.

a. Approximate Short Circuit Capability

At future Aniani Substation bus (1994) at 138 kV.

Three phase fault	Maximum	12.3 kA
Single phase-to-ground fault	Maximum	7.6 kA

b. 1994 System Impedance

(per unit - 100 MVA base)

Positive Sequence Z1 = .0093 + j.0333
Zero Sequence Z0 = .0186 + j.0846

See Figures 3.7A and 3.7B for positive and zero sequence branch data.

c. Load Flow Diagrams

Load flow data for the HECO system at peak, minimum and average load for 1994, prior to energization of the HVDC transmission line, are given on Figures 3.7C, D and E, respectively.

d. One Line Diagrams

The one-line diagram for the HECO 138 kV system with the Aniani Substation and the converter terminal is shown in Figure 3.7F.

e. Machine Data

Turbine, engine, and generator data which can be used for preliminary system studies are shown on the following figures:

HECO generator data - Figure 3.7G
HECO turbine data - Figure 3.7H
HECO customers generator and turbine data, Figure 3.7I

3.7.2.3 Existing Equipment Ratings and Operating Stresses

The ratings of equipment at the receiving substation on Oahu and generally in use on the island of Hawaii are shown in the following table:

Equipment	Rating
Transmission voltage	138 kV
Basic insulation level	
External insulation	650 kV
Internal insulation	550 kV
Surge arrester rating	108 kV
Breaker and current rating	
Continuous current rating	2 kA
Interrupting rating	40 kA

All three islands are subject to salt contamination and agricultural pollution. Distance from the sea, prevailing winds, and rugged terrain all affect the severity of contamination. Generally, the island utilities go up one or two voltage levels in selecting insulators for the lower voltages and base the application for 138 kV on leakage distance and local conditions.

There is no data available on actual contamination severity in terms of an accepted standard measuring technique such as equivalent salt deposit density. HECO, however, bases the number of insulators and the type of insulators used on 138 kV lines on the distance of the facility from the coast and its application. The following table shows HECO practice for the insulation areas shown in Figures 3.7J, K and L.

Equipment	Area A			Area C		
	#	kV/Unit	Type	#	kV/Unit	Type
Strain Bus	12	6.7	Std	10	8	Std
Target Tower	8	10	Fog	8	10	Std
Deadend Tower	13	6.2	Std	10	8	Std

Historical data from several sources classify a requirement of 10 kV/unit stress for acceptable contamination performance on AC as equivalent to a contamination severity of 0.08 to 0.1 mg/cm2. If the same stress was used for 300 kV DC, about 30 insulators would be needed on each pole depending on the type of insulator used. The PROPOSER must be aware of the severity of salt contamination in the Hawaiian Islands and provide information in the Proposal on proposed mitigation measures for line and station insulation, with particular attention to HVDC wall bushings in the converter stations.

Figures 3.7 J, K and L are insulation area maps for Hawaii, Maui and the Waimanalo Bay area of Oahu. In establishing these recommendations, HECO uses insulators with 0.986 inch of leakage or creep distance per kV phase-to-phase for Area "A" and 0.667 inch/kV for Area "C".

For support insulation, the use of 650 kV BIL results in a leakage distance of 0.84 inch/kV, or roughly half way between the near coast and away-from-coast criteria.

HECO also uses silicone in areas where outages caused by contamination have increased beyond an acceptable number. The following HECO criteria and instructions for usage of silicone compounds are included to assist the PROPOSER in evaluating the contamination problem:

- Silicone compound is applied by hand, preferably, or brush if necessary in such a manner that the coating has a minimum thickness of 1/16 inch.

- Due to the relatively short length of time this silicone compound coating has been in use, there is no reliable information on the length of time for which it is effective. This is determined from field experience at each location.

- The following procedures for determining replacement and/or frequency necessary for replacement of silicone compound are used:

  a. Record all initial installations of compound as to date, location and circuit voltage.

  b. Make periodic inspections for indications of flashover or arcing of insulators coated with compound.

  c. Do not replace compound merely because it appears dirty; an inherent property of this coating is that it traps and insulates contaminants.

  d. Replace compound only when a visual examination shows definite evidence of arcing to insulator base or pin, or flashover across the insulator or bushing.

  e. Replace compound only on insulators or bushings in the immediate area, or if an overhead line, on structures immediately adjacent to failure.

  f. In case of flashover, determine exactly where flashover occurred and record location and circuit voltage.

g. Record all replacements of compound as to date, location and circuit voltage.

3.8 INTERCONNECTION REQUIREMENTS AT RECEIVING SUBSTATION

The location for the inverter on Oahu is not fixed and is the responsibility of the DEVELOPER. However, the receiving substation has been tentatively located at an undeveloped site called Aniani. This 3.6 acre site is about three miles inland from the shoreline along Waimanalo Bay. Depending on the exact location of the cable landing and the site of the converter station, the 138 kV lines to Aniani Substation could be 1/4 to three miles long. It is possible that the 300 kV HVDC cable could be brought ashore and taken inland underground to a converter station near Aniani Substation. In this case the 138 kV interconnection would be very short.

A preliminary sketch of the Aniani Substation is shown in Figure 3.8A. Revenue metering for the power received by HECO will be at Aniani Substation and the DEVELOPER will be responsible for the interconnecting AC lines.

HECO's requirements for the Waimanalo converter terminal are as follows:

- The AC voltage at the Waimanalo converter terminal shall be 138 kV when the converter terminal is operating as the lowest voltage inverter in the bipolar mode.

- The nominal power rating of the Waimanalo conveter terminal shall be 500 MW when the converter terminal is operating as an inverter in the bipolar mode.

- To account for contingencies, the continuous overload rating of the Waimanalo converter terminal shall be

375 MW when the converter terminal is operating as an inverter in the monopolar mode.

3.9 SYSTEM OPERATION, MONITORING COMMUNICATION AND MAINTENANCE

The integration of a HVDC link into an AC system, even as a link between two strong systems (high short circuit ratios) or between a large generation source and a strong system, must be very carefully studied and analyzed. This Project adds a measure of complication to that process in that the degree of cycling capability in the geothermal generation source is unknown, and thus the amount of control of the HVDC power level and AC voltage is also unknown. The HECO AC system is also relatively small in comparison to the complete Project HVDC MW capacity (equivalent short circuit ratio is six at peak load and about 2.5 at minimum load), which reduces the controllability of the HVDC system during AC fault conditions. The HVDC system by itself is normally very flexible and highly controllable in that control of power magnitude, VAR consumption (voltage), frequency and power modulation can all be built into the HVDC control. Furthermore, the DC system can be monitored and operated remotely at either the bipole or pole level. The PROPOSER should clearly identify the amount and phasing of electric generation that is proposed and clearly identify how this is related to the overall Project control scheme.

3.9.1 OVERALL SYSTEM INTEGRATION AND TELECONTROL

Block diagrams and an explanation for the integration strategy for coordination of the geothermal resource electric generation, the HVDC transmission, and HECO dispatching and load requirements should be included in the Proposal. Complete control diagrams for the HVDC system should be shown in the responses to Section 3.6.8, along with other details of the converter terminal control functions.

The Proposal should describe how and to what degree it is intended to vary the output of the geothermal generation to meet the HECO daily load variations as described in Section 5. The PROPOSER should assume that HECO will regard the Project as a base load source, with control of the Project output the responsibility of the DEVELOPER. HECO will transmit verbal orders for power changes as dictated by HECO system requirements. The DEVELOPER will operate and dispatch the geothermal units. If the PROPOSER includes a geothermal well, energy gathering system, and power production facility design which allows significant cycling, the HVDC and generation control scheme should include a tie to HECO's control center in Honolulu which permits HECO to dispatch that cycling power to the extent allowable.

3.9.2 COMMUNICATION AND TELECONTROL

HECO, MECO, and Hawaii Electric Light Company (HELCO) each own and operate an island-wide communications network, within their own service territory, consisting of private-carrier microwave, mobile radio, and land lines. HECO has an active fiber optic network; HELCO is in the process of installing a fiber optic system. A HECO Inter-Island Communications System (ICS) is proposed to be in operation by the end of 1989, and will provide voice and data communication channels via microwave interconnecting all three island utilities. The HELCO terminus for the ICS will be near Huehue Ranch in the North Kona district, and the MECO terminus at Kahului. Communications coverage of the Puna district is via mobile radio only at this time. A microwave link between HELCO's Kanoelehua Power Plant in Hilo to the Ormat geothermal plant in Puna is scheduled to be operational by the end of 1990. All the utilities also lease telephone circuits for special applications and backup.

HECO and HELCO may provide channels on the ICS and the analog microwave system, respectively, to the DEVELOPER for communications, telemetering and control needs if they are used to provide HECO load requirement information to and from the HVDC system, provided that 1) the DEVELOPER'S telecontrol scheme is compatible with the HECO and HELCO systems, 2) sufficient channels are available on the ICS and HELCO's analog microwave system and 3) the DEVELOPER provides the interface between the ICS and DEVELOPER'S control center, all at DEVELOPER'S cost. The DEVELOPER must still supply an independent communication and telecontrol scheme as described in Section 3.6.9 for control of the HVDC system. The Proposal should describe in detail any proposed use of the HECO, MECO and HELCO communications facilities.

3.9.3 MONITORING AND REVENUE METERING

Since the DEVELOPER will operate and dispatch the geothermal electric production facilities and control the HVDC transmission system, provision for monitoring of the DEVELOPER'S power, voltage and current measurements by HECO is not mandatory. For purposes of evaluation, the PROPOSER should include a block diagram and description of the internal monitoring and telecontrol system between the HVDC system, the AC collection system and the electric power production facilities.

Revenue metering of the power purchased by HECO will be accomplished at the point of interconnection at HECO's Aniani Substation, shown on Figure 3.6E. For billing purposes, electric energy output of the DEVELOPER'S facilities at the point of interconnection shall be measured in KW and KWH on a time of use basis. Reactive power flow will be measured in KVAR and KVARH. Metering equipment shall be of two percent (2%) accuracy and calibrated and tested periodically according to HECO standards.

3.9.4 MAINTENANCE PRACTICES AND ORGANIZATION

The DEVELOPER, will be responsible for the operating practices, maintenance organization and procedures adopted to operate and maintain the system in order to obtain the reliability and availability standards set forth in the PPA. The PROPOSER should follow recognized standards, rules, and guidelines for design, construction, and rating of all electrical and mechanical equipment. Furthermore, it is expected that the operating and maintenance practices adopted will closely follow those in common use by HECO for their facilities. For evaluation purposes, the PROPOSER is requested to provide a detailed description of the proposed operating organization with a complete Organization Table as it is perceived at the time of response to this RFP.

3.10 BIBLIOGRAPHY

The following Bibliography is taken from the Hawaii Deep Water Cable Program, Phase II-D, Task 5, Section 2.

SECTION 2

HDWCP REPORT LISTING

DATE	TITLE	CORPORATE AUTHOR	AUTHORS	FUNDING SOURCE	CALL NO	PAGES
** SUBJECT AREA: General Management and Administration						
1982	General Management Reports	Parsons Hawaii	Chapman, G.A.	Hawaii Department of Planning and Economic Development	001	4 Sections
1982	Management Support Reports	Parsons Hawaii	Chapman, G.A.	Hawaii Department of Planning and Economic Development	002	3 Sections
1984	Program Integration Plan	Parsons Hawaii	Krasnick, G. and G.A. Chapman	U.S. Department of Energy	003	9 Sec+2App
1984	Technical Standards/Engineering Procedures Guidelines	Parsons Hawaii	Chapman, G.A. and G. Krasnick	U.S. Department of Energy	004	10
** SUBJECT AREA: Cable Subsystem						
1982	Development of Candidate Cable Designs for the Hawaiian Deep Water Cable Program	Simplex Wire and Cable Company		Hawaii Department of Planning and Economic Development	101	61 + 2 App
1982	Development of Cable Design for the Hawaiian Deep Water Cable Program (Draft)	Simplex Wire and Cable Company	Traut, R., J. Soden, J. Kurt and R. Costantino	Hawaii Department of Planning and Economic Development	102	111+2App
1982	Development of Preliminary Cable Design for the Hawaiian Deep Water Cable Program	Simplex Wire and Cable Company	Traut, R., J. Soden, J. Kurt and R. Costantino	Hawaii Department of Planning and Economic Development	103	112+3App
1982	Preliminary Prototype Cable Design Criteria	Simplex Wire and Cable Company	Traut, R., J. Soden, J. Kurt and R. Costantino	Hawaii Department of Planning and Economic Development	104	112 + 3App
1983	Cable Design Reassessment (Draft)	Simplex Wire and Cable Company		U.S. Department of Energy	105	50 + 1 App
1985	Cable Transportation from Manufacturing Plant to Hawaii	Hawaiian Dredging & Construction Company	Slayton, M. T.	U.S. Department of Energy	106	6 Sec+1App

SECTION 2

HDWCP REPORT LISTING

DATE	TITLE	CORPORATE AUTHOR	AUTHORS	FUNDING SOURCE	CALL NO	PAGES
1985	Cable Subsystem Feasibility Criteria	Parsons Hawaii		U.S. Department of Energy	107	4 Sec
1985	Cable Selection Methodology	Parsons Hawaii		U.S. Department of Energy	108	5 Sec
1985	Test Cable Selection	Parsons Hawaii		U.S. Department of Energy	109	14 Sec
1985	Cable Construction Specification	Pirelli Cable Corporation		U.S. Department of Energy	110	29
1985	Cable Design Parametric Study	Pirelli Cable Corporation and Societa Cavi Pirelli	Silver, D., L. Bonacorsa, G. Bazzi and D. Valenza	U.S. Department of Energy	111	10Sec+5App
1986	Cable Overloadability Study	Pirelli Cable Corporation and Societa Cavi Pirelli		U.S. Department of Energy	112	17 + 20 Tb
1986	Cable Catenary Study	Pirelli Cable Corporation and Societa Cavi Pirelli		U.S. Department of Energy	113	16 + 1 App
1986	Cable Repair Rationale	Pirelli Cable Corporation and Societa Cavi Pirelli		U.S. Department of Energy	114	23 + Maps
1986	Final Design of Flexible Factory and Field Joints and Terminations	Pirelli Cable Corporation and Societa Cavi Pirelli		U.S. Department of Energy	115	69 + Dwngs
1986	Cable Repair Rationale	Hawaiian Dredging & Construction Co., Pirelli Cable Corporation and Makai Ocean Engineering		U.S. Department of Energy	116	25 + 3 App
1988	Development of Friction Test Specimen for the HDWC System	University of Hawaii, Department of Mechanical Engineering	Knapp, R.M.	Hawaii Department of Business and Economic Development	117	7
1989	Cable Laboratory Test Program Report	Pirelli Cable Corporation and Societa Cavi Pirelli		U.S. Department of Energy	118	15 Sec+4Ap
1988	Revised Basic Design Criteria Data Book	Parsons Hawaii		State of Hawaii	119	12

TABLE 3.7A
PHYSICAL CONDITIONS

	Condition	Hawaii	Maui	Oahu
(a)	Altitude (feet)	1100 (at Puna)	30 (at Maalaea)	about 100 (at Aniani)
	tentative line routes		0 to 3000	
	Over saddle road	1100 to 6500		
	Along Hamakua Coast	1000 to 2000		
(b)	Air Temperatures Outdoor air temperature			
	maximum	81.3°F	83.1°F	85.6°F
	minimum	55.0°F	55.0°F	55.0°F
(c)	Wind Velocity Maximum (1 minute duration) mph	34.9	32.9	29
	Maximum Gust mph	45	45	41
(d)	Rainfall Average Annual	22 in	3.7 in	3.6 in
	Maximum in One Hour	1.8 in	0.6 in	1.3 in
(e)	Lightning Incidence Keraunic Level (Thunderstorm days/year)	8	8	8
(f)	Seismic Conditions Earthquake Zone	3	2	1
(g)	Cooling Water	Well	Well	Well
(h)	Converter Site Soil Description	(Puna) Histosols Inceptisols	(Maalaea) Mollisols Incepti-sols, Misc.	(Waima-nalo) Entisols, Mollisols Vertisols Ultisols

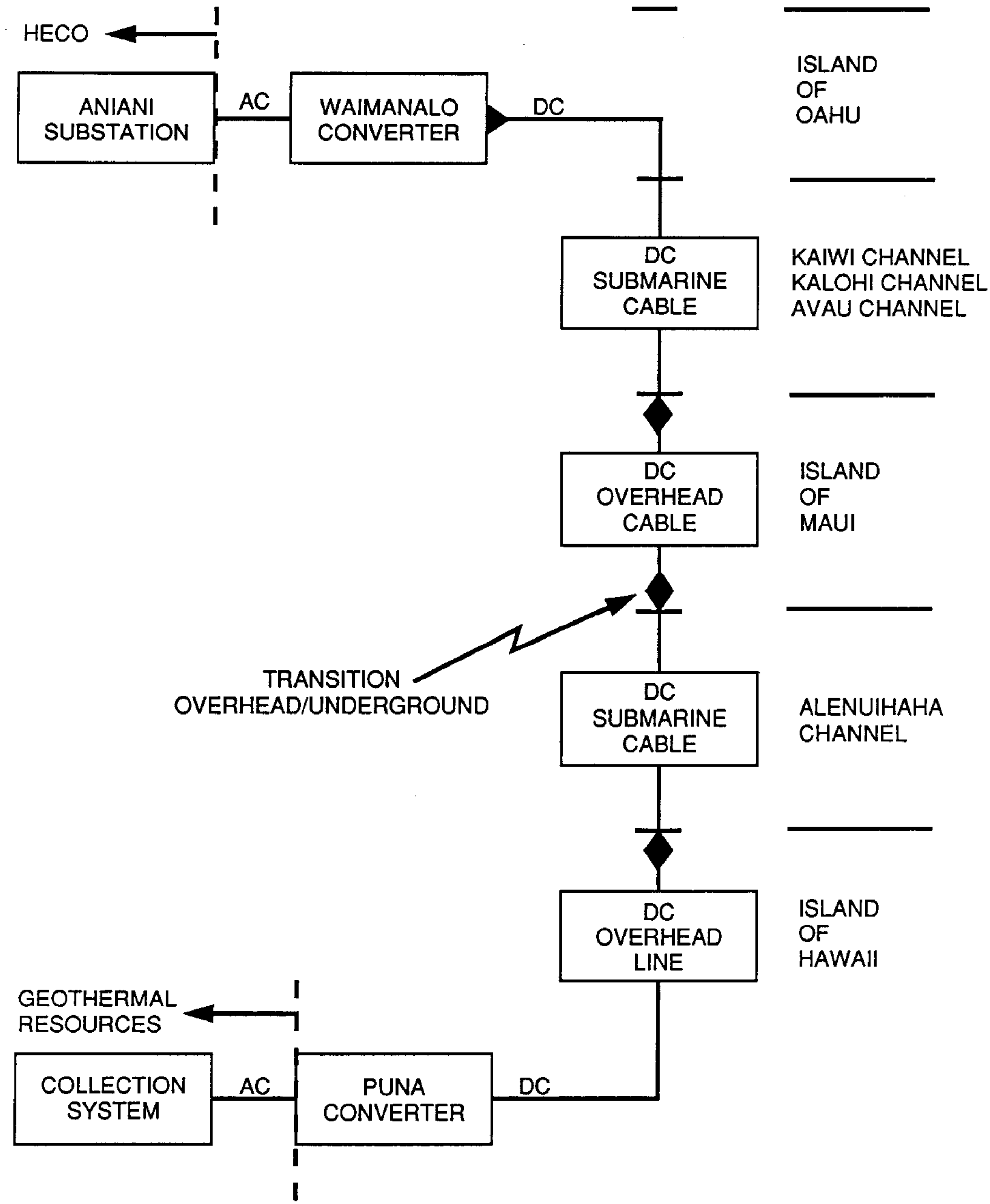


FIGURE 3.5A
GEOTHERMAL POWER TRANSMISSION SYSTEM

M0389191

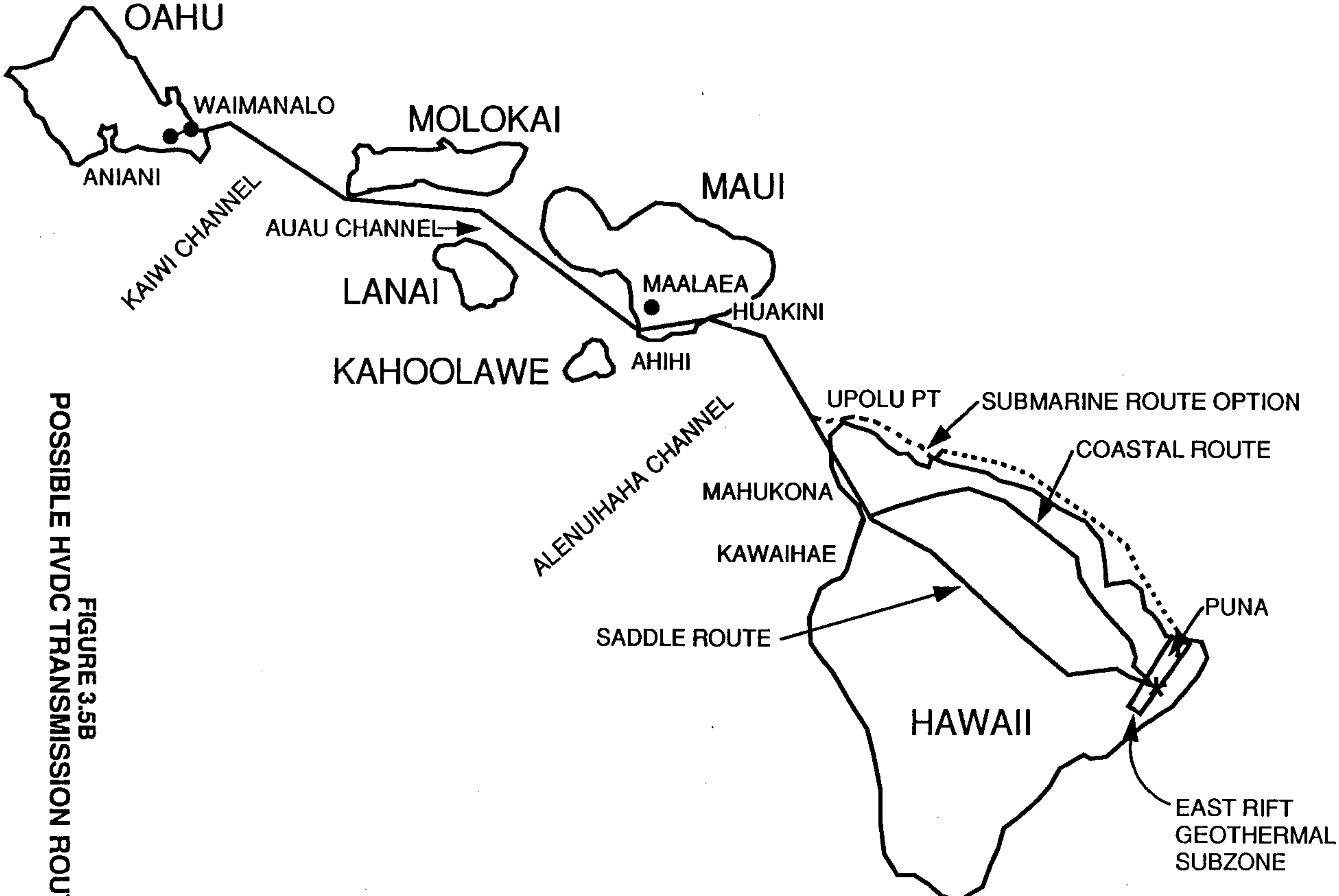


FIGURE 3.5B
POSSIBLE HVDC TRANSMISSION ROUTES

M0489012

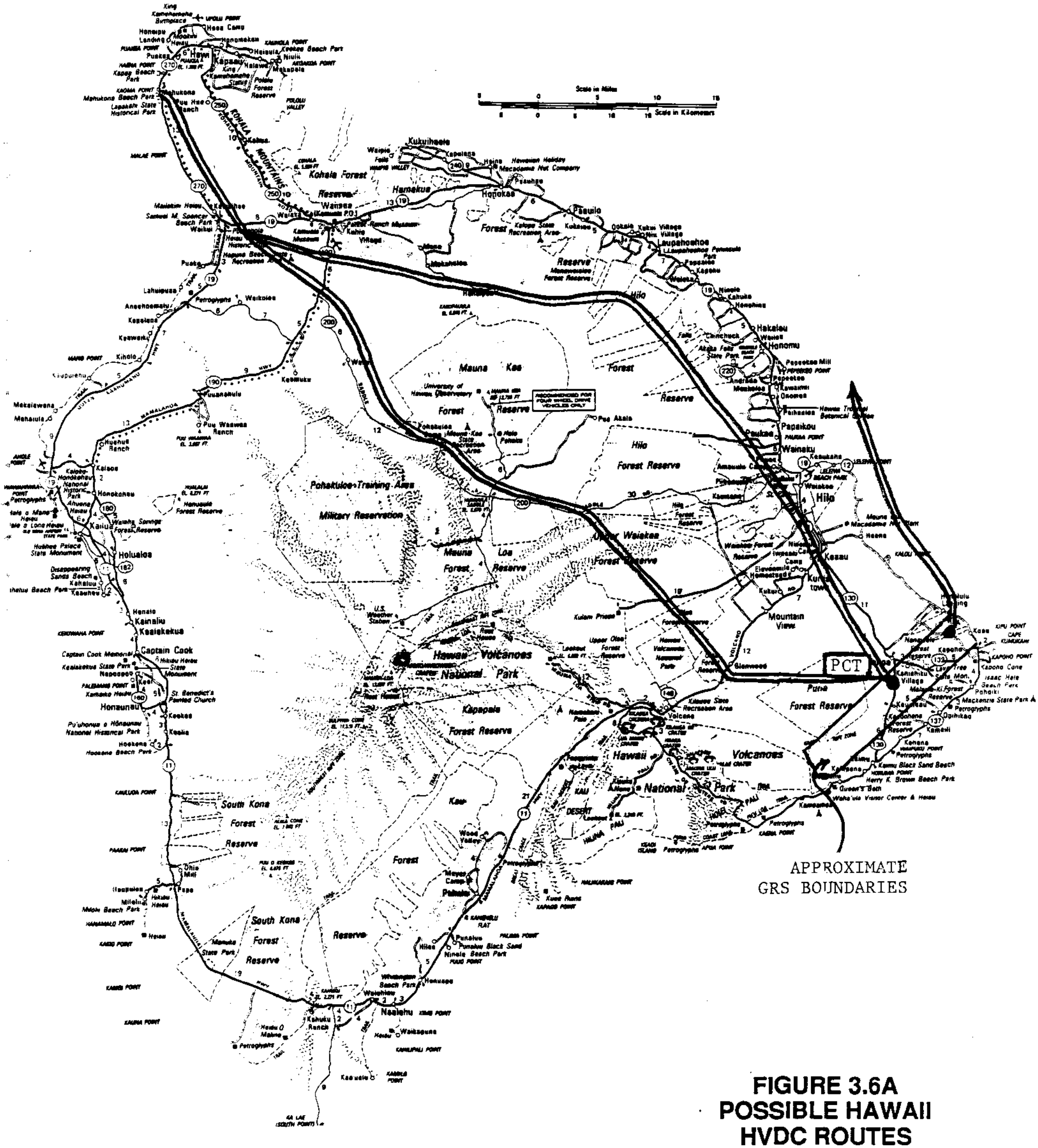


FIGURE 3.6A
POSSIBLE HAWAII
HVDC ROUTES

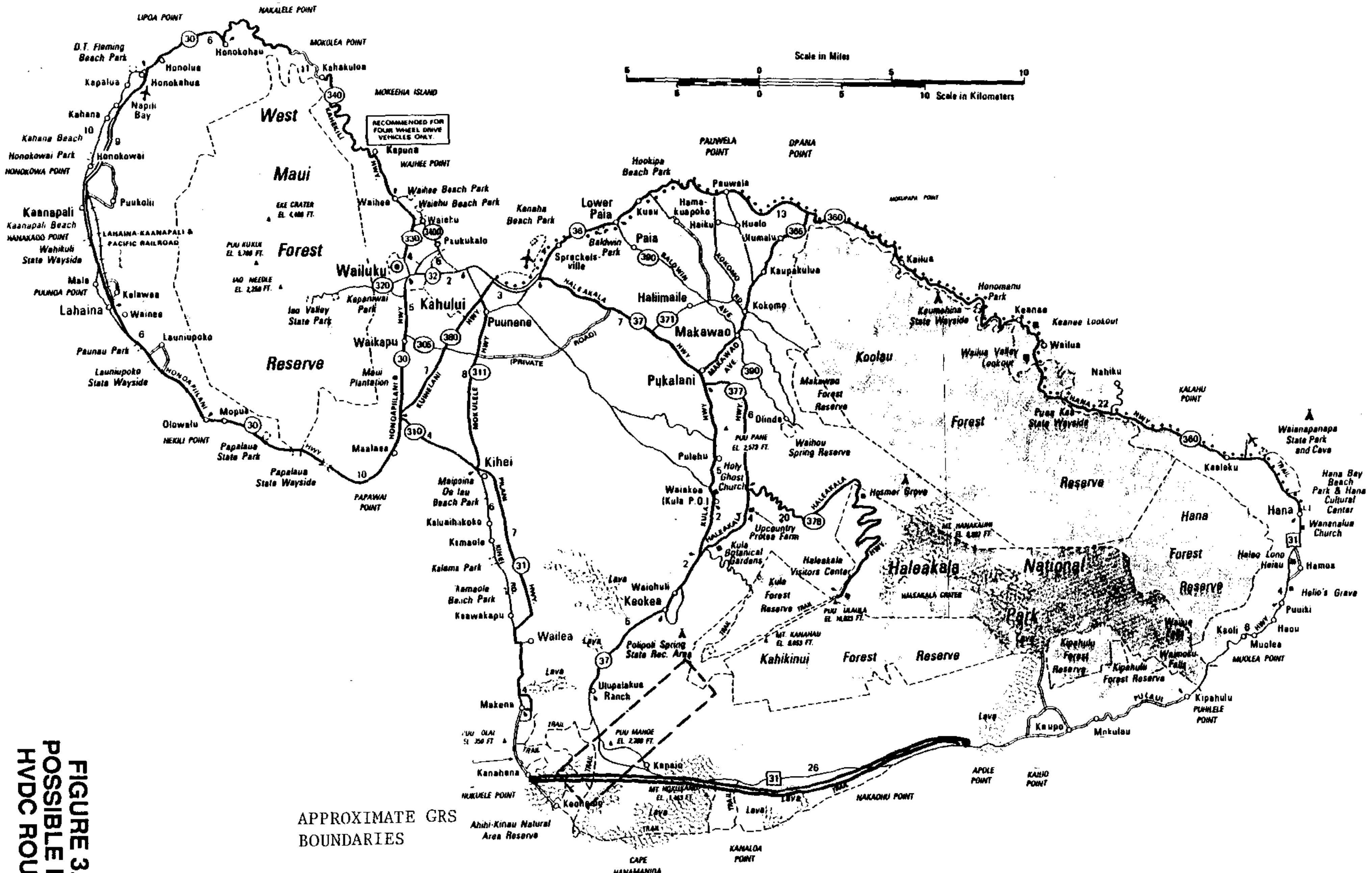


FIGURE 3.6B
POSSIBLE MAUI
HVDC ROUTES

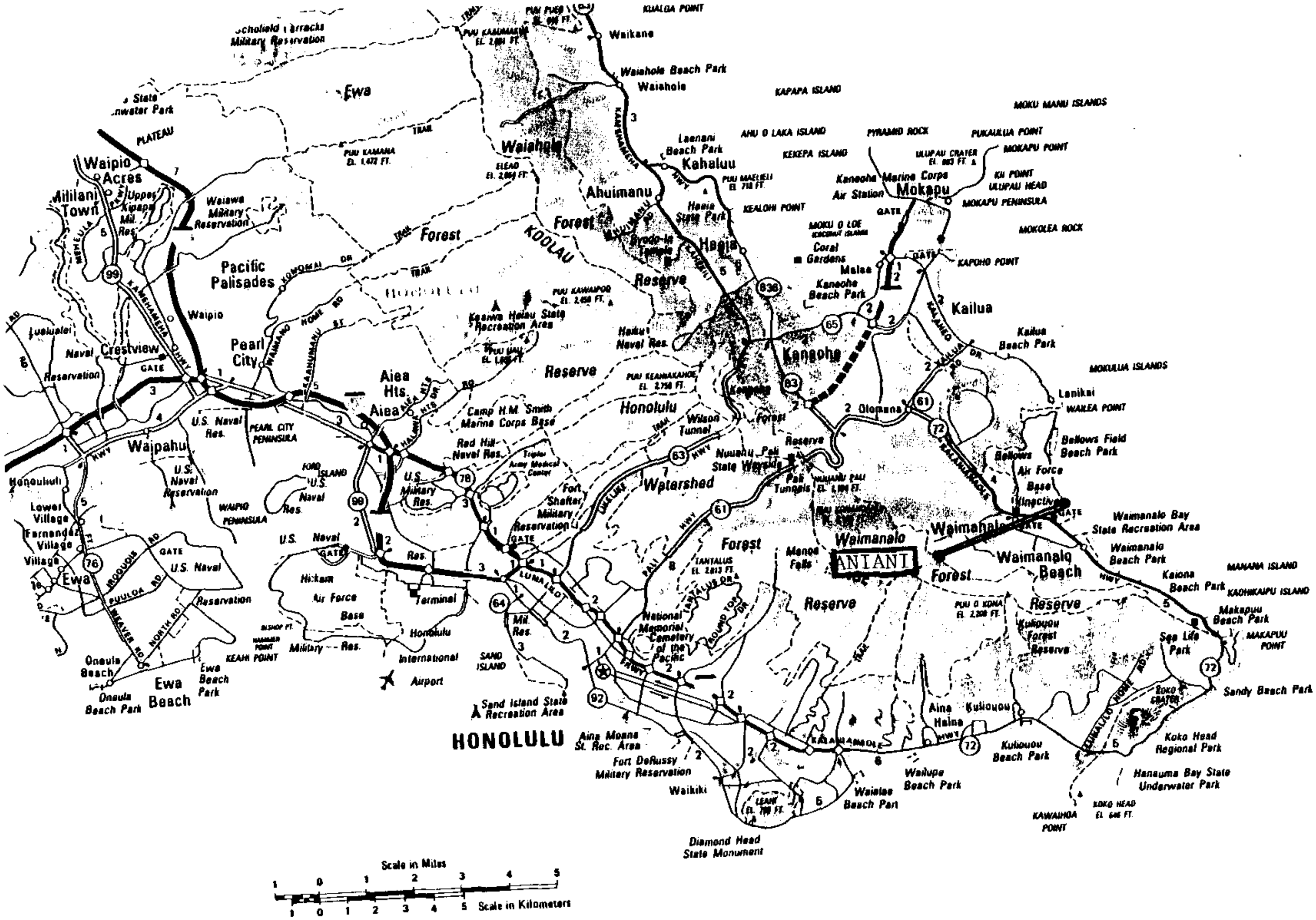


FIGURE 3.6C
POSSIBLE OAHU
HVDC ROUTES

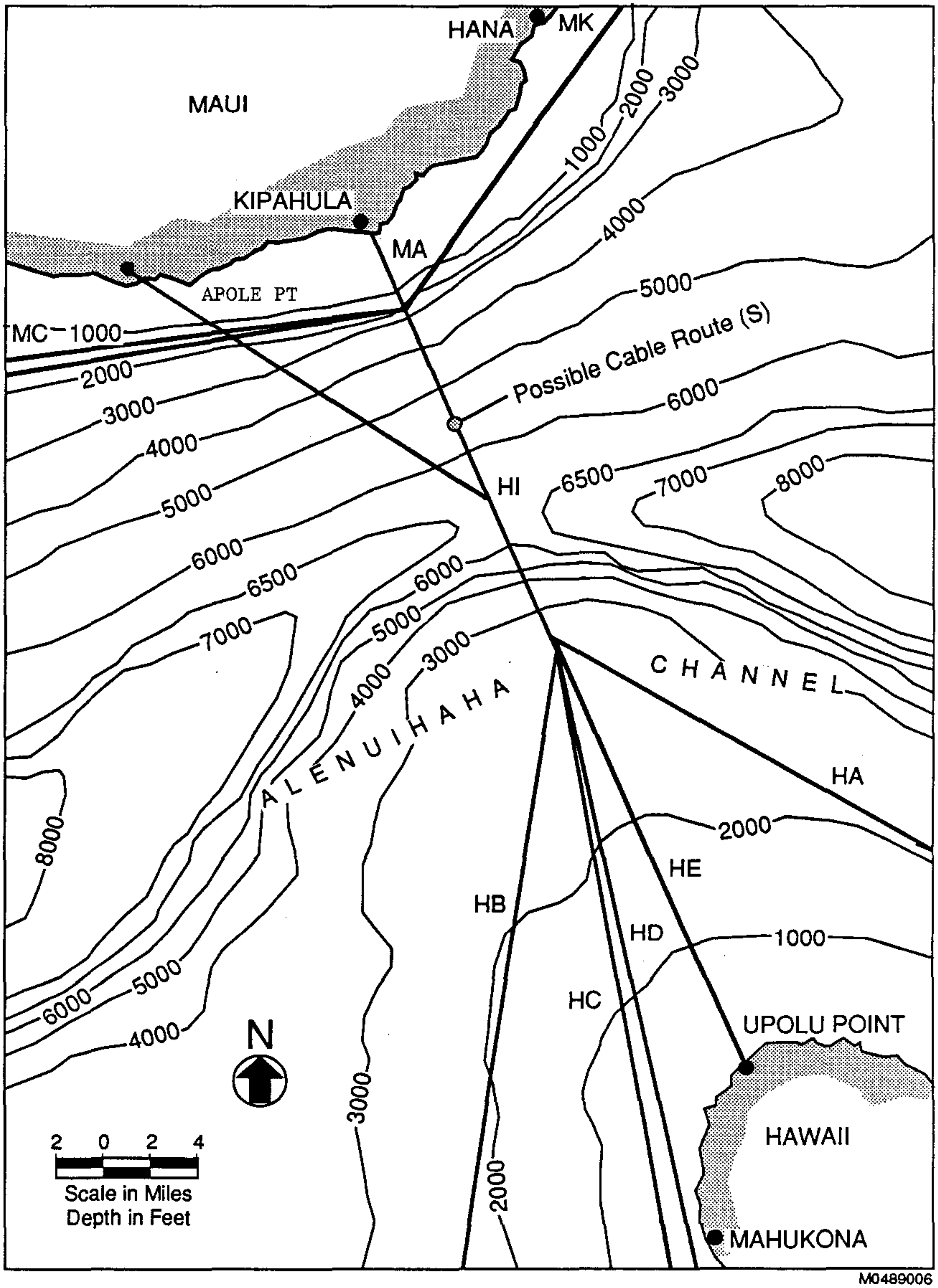


FIGURE 3.6D

POTENTIAL HAWAII TO MAUI CABLE ROUTES

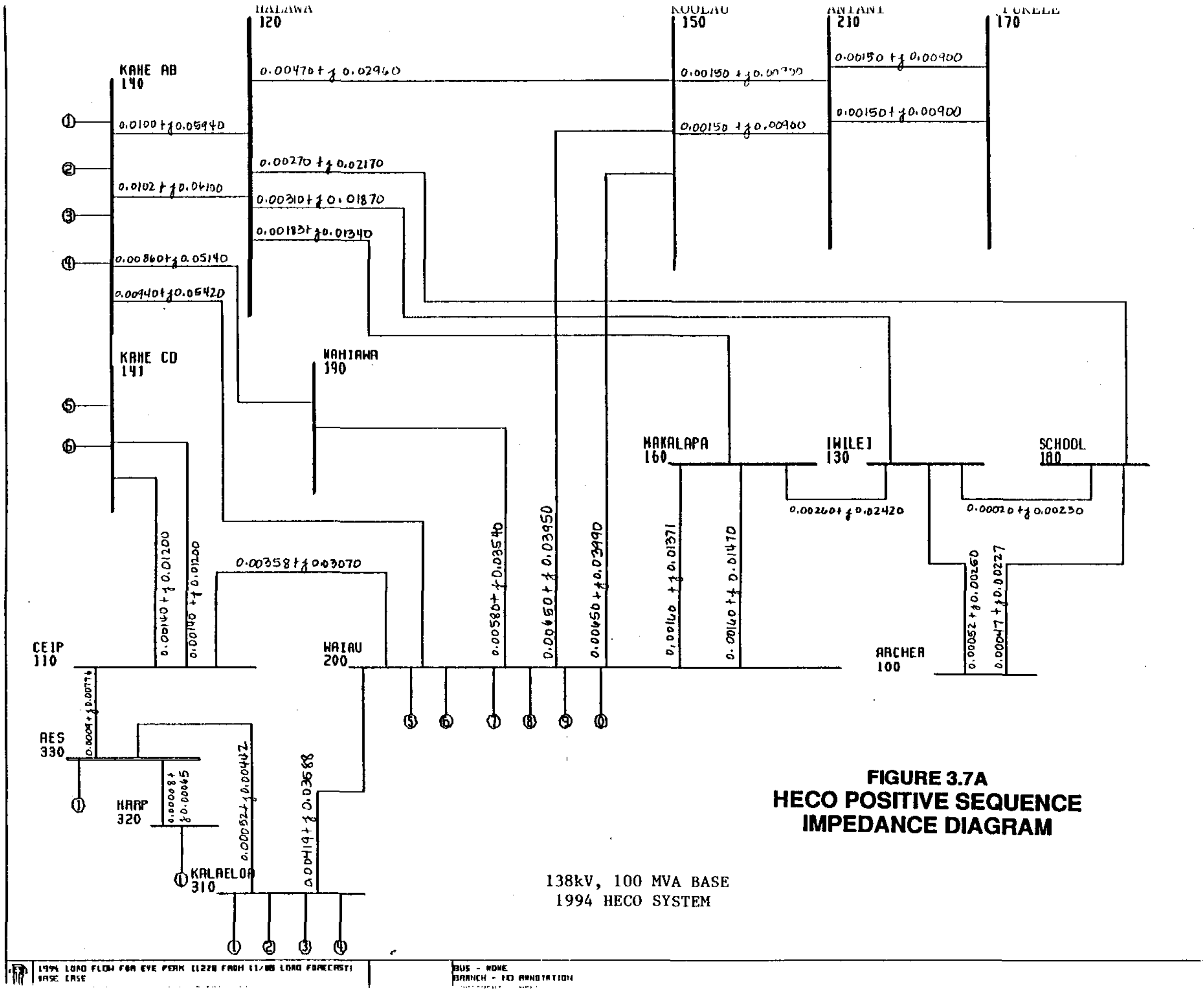


FIGURE 3.7A
HECO POSITIVE SEQUENCE IMPEDANCE DIAGRAM

138kV, 100 MVA BASE
1994 HECO SYSTEM

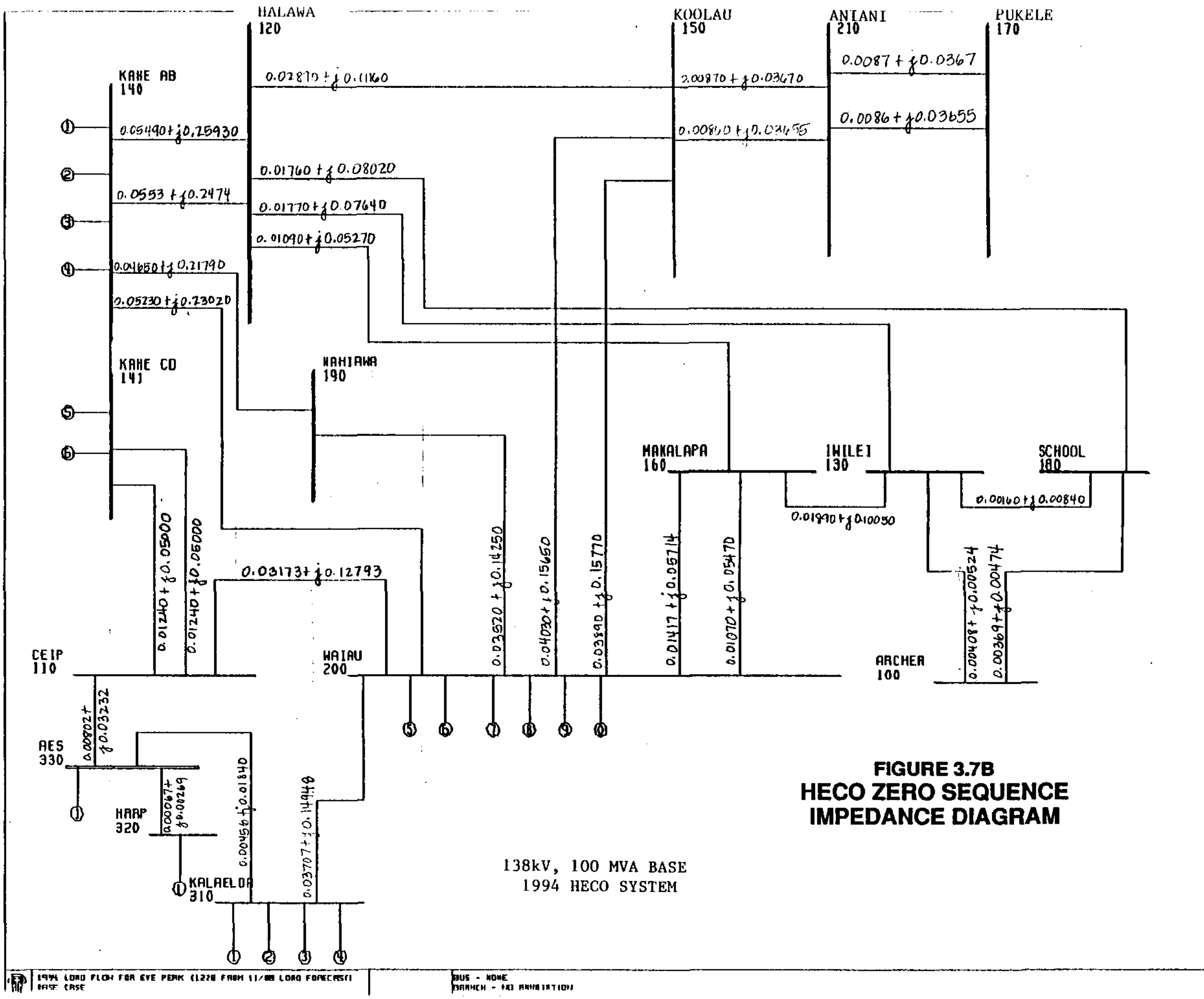


FIGURE 3.7B
HECO ZERO SEQUENCE IMPEDANCE DIAGRAM

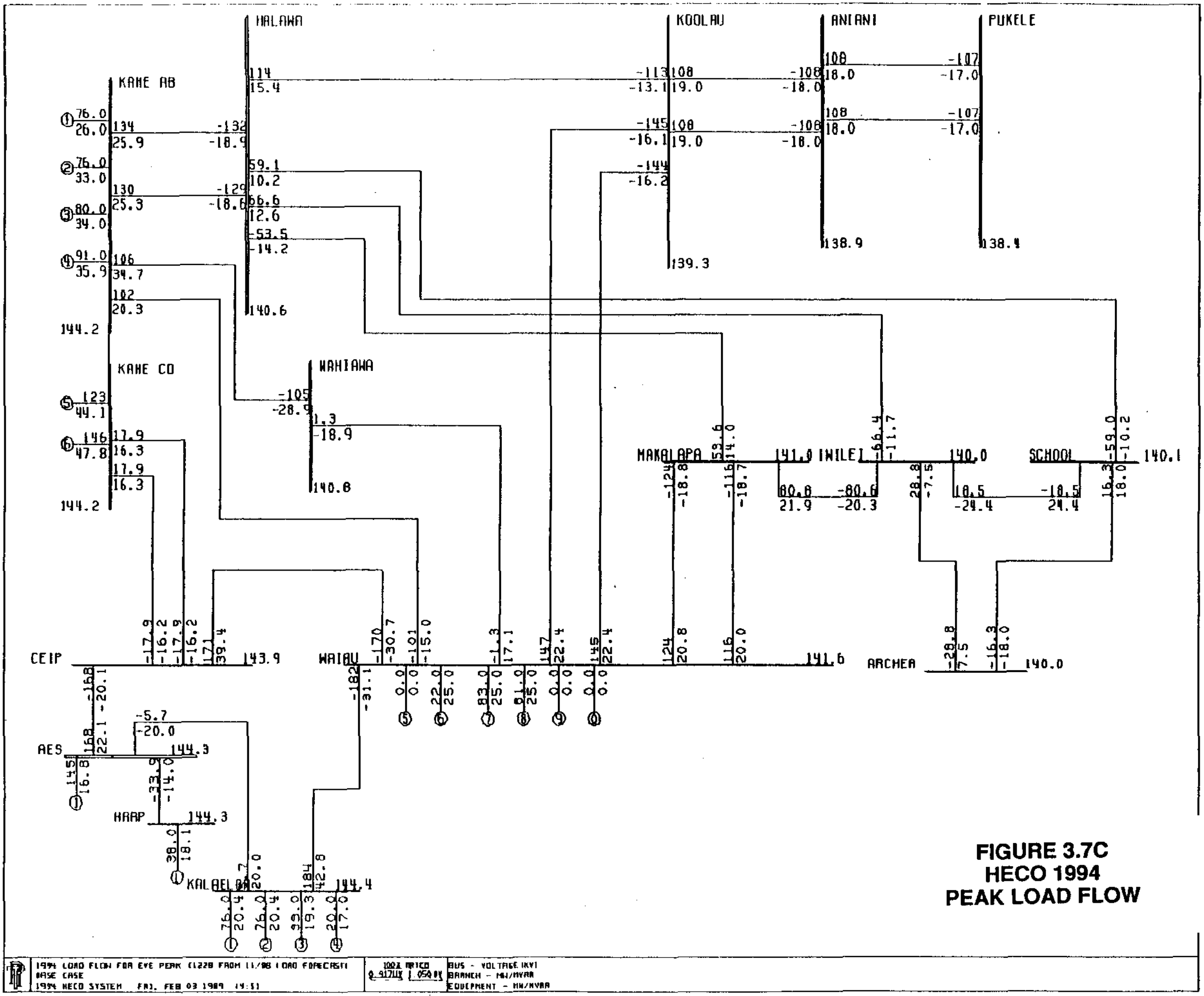


FIGURE 3.7C
HECO 1994
PEAK LOAD FLOW

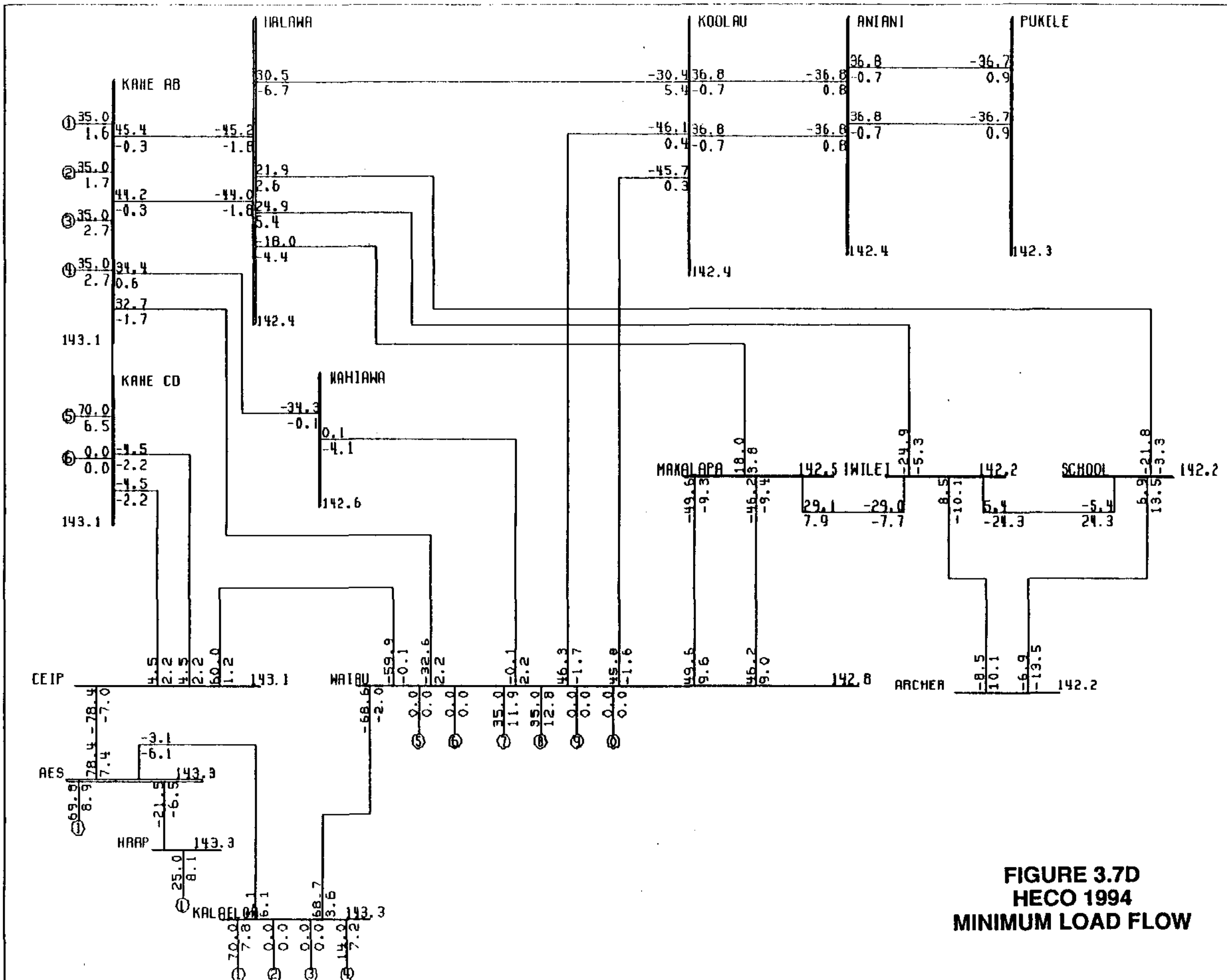


FIGURE 3.7D
HECO 1994
MINIMUM LOAD FLOW

1994 LOAD FLOW FOR MIN LOAD (479 FROM 11/88 LOAD FORECAST)
BASE CASE
1994 HECO SYSTEM FRI, FEB 03 1989 14:53

100% RATED
0.917UV 1.050UV

BUS - VOLTAGE (KV)
BRANCH - MW/MVAR
EQUIPMENT - MW/MVAR

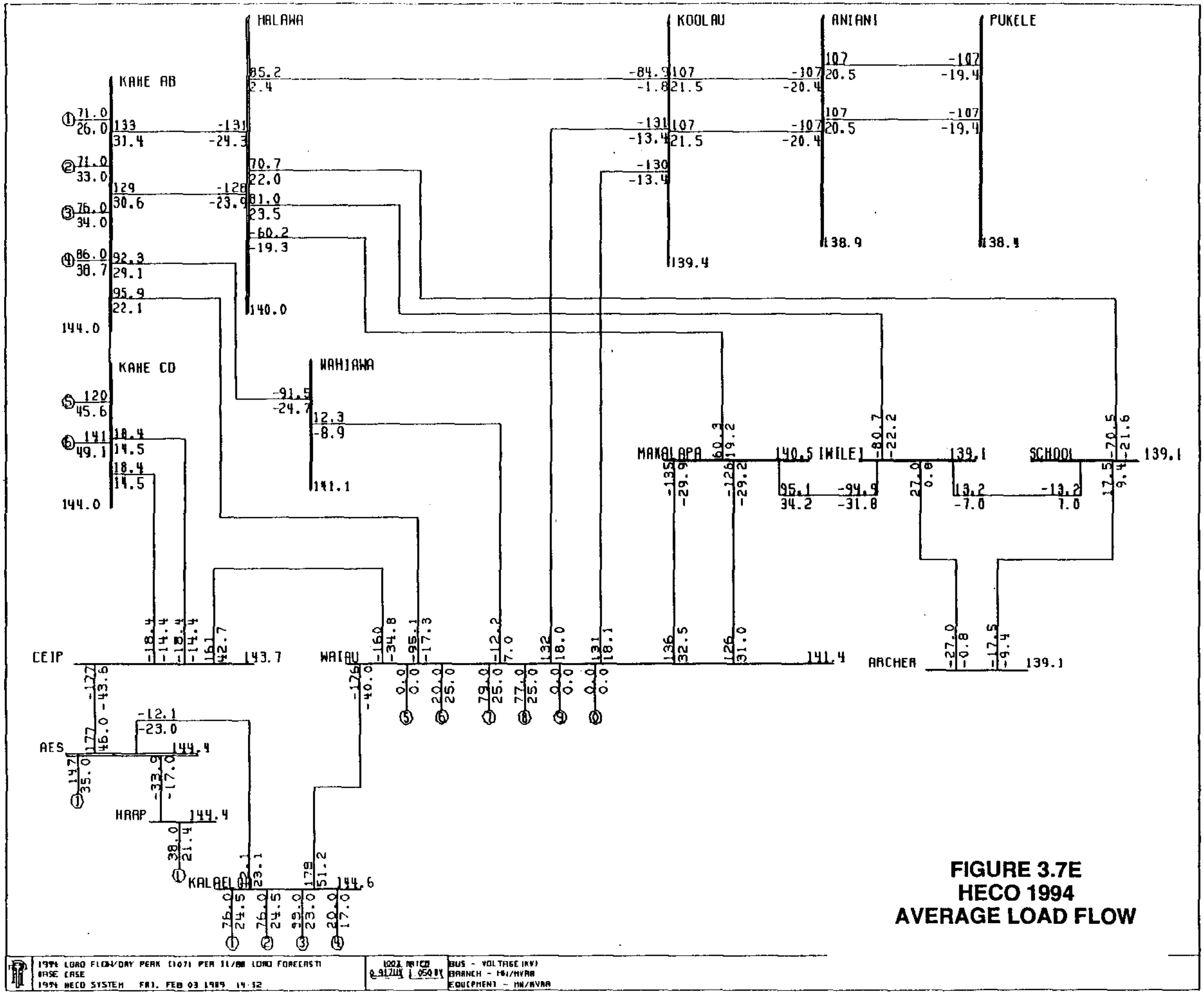
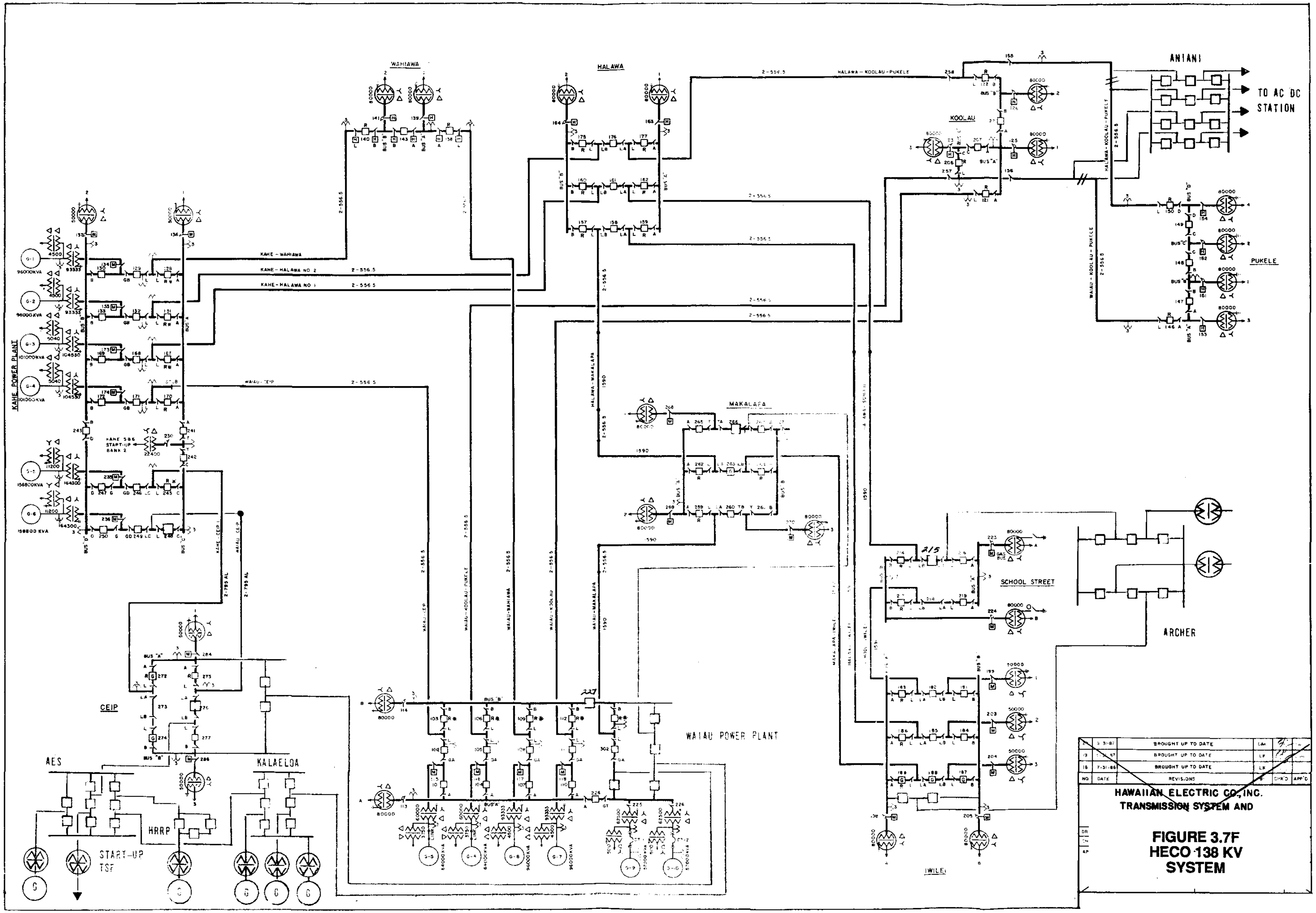


FIGURE 3.7E
HECO 1994
AVERAGE LOAD FLOW



WAHIAWA
HALAWA
ANIANI
TO AC DC STATION
KOOLAU
PUKELE
KAHE POWER PLANT
MAKALAPA
SCHOOL STREET
ARCHER
CEIP
AES
START-UP TSF
HRRP
KALAELOA
WAIAU POWER PLANT
IWILEI
KAHE - WAHIAWA
KAHE - HALAWA NO 2
KAHE - HALAWA NO 1
WAIAU - CEIP
HALAWA - KOOLAU - PUKELE
WAIAU - KOOLAU - PUKELE
HALAWA - MAKALAPA
WAIAU - MAKALAPA
WAIAU - WAHIAWA
WAIAU - KOOLAU
KAHE - CEIP
WAIAU - CEIP
2-795 AL
2-556.5
1590
BROUGHT UP TO DATE
BROUGHT UP TO DATE
BROUGHT UP TO DATE
NO
DATE
REVISIONS
CHK'D
APP'D
HAWAIIAN ELECTRIC CO., INC.
TRANSMISSION SYSTEM AND
FIGURE 3.7F
HECO 138 KV
SYSTEM

FILE: GENPP 16-8
COMPUTER FILE: XPHEGENR LISTING
HAWAIIAN ELECTRIC COMPANY SYSTEM

H. E. CO. GENERATOR DATA

UNIT	DATE OF COMMERCIAL OPERATION	MAXIMUM NAMEPLATE RATING KW (4)	KVA	PSI	RATED KV	WR2 LB-FT2	P.F.	IF	SCR	I_2^2T	PERCENT ON MAXIMUM NAMEPLATE KVA BASE Xd	X'd	X''d	Xo	PERCENT ON RATED KV-100MVA BASE Xd	X'd	X''d	Xo	T-MF
HONOLULU																			
1**	6/10/20	10,000	12,500	A	11.0	77,000	.80	275	.92	30	106	24.4	12.9	9.0	848	195.2	103.2	72.0	
+++2**	12/28/21	10,000	12,500	A	11.5	77,000	.80	290	1.15	30	89.8	11.8	8.8	2.5	718	94.4	70.4	20.0	
3**	6/09/25	10,000	12,500	A	11.0	77,000	.80	275	.92	30	106	24.4	12.9	9.0	848	195.2	103.2	72.0	
+5**	4/20/30	(20,000)	25,000	A	11.0	70,100	.80	410	1.13	30	102	20.0	14.0	2.5	408	80.0	56.0	10.0	
++6**	10/07/33	10,000	12,500	A	11.5	11,500	.80	225	.99	30	118	14.4	7.2	2.8	944	115.2	57.6	22.4	
7**	9/01/44	35,000	43,750	.5	11.0	37,400	.80	575	.98	30	140	19.8	11.3	4.0	278	39.4	22.5	8.0	
8	12/17/54	50,000	62,500	30	11.5	41,600	.80	685	.90	30	151	20.8	12.3	7.4	242	33.3	19.7	11.8	
9	12/09/57	54,400	64,000	30	11.5	41,600	.85	680	.64	30	155	21.2	12.5	7.6	242	33.1	19.5	11.9	
WAIAU																			
1**	6/20/38	(7,500)	9,375	A	11.0	7,850	.80	340	1.00	30	129	16.3	8.2	2.4	1376	173.9	87.5	25.6	
2**	8/29/40	(15,000)	18,750	A	11.0	16,100	.80	273	.93	30	125	15.5	9.7	3.2	667	82.7	51.7	17.1	
3	12/01/47	50,000	57,500	15	11.0	44,500	.87	642	.92	30	143	19.6	11.6	1.5	249	34.1	20.2	2.6	
4 (1)	10/25/50	50,000	57,500	15	11.0	44,500	.87	642	.92	30	143	19.6	11.6	1.5	249	34.1	20.2	2.6	
5	10/09/59	54,400	64,000	30	11.5	41,600	.85	660	.64	30	155	21.2	12.5	7.6	242	33.1	19.5	11.9	
6	7/28/61	(54,400)	64,000	30	11.5	40,139	.85	663	.64	30	155	21.2	12.5	7.6	242	33.1	19.5	11.9	
7 R	12/01/66	(81,600)	96,000	30	14.4	65,625	.85	849	.64	30	150	(E)16.7	10.1	1.5	156	(E)17.4	10.5	1.6	
												(I)19.0				(I)19.8			
8 R	12/16/68	(81,600)	96,000	30	14.4	65,625	.85	848	.58	30	150	(E)16.7	10.1	1.5	156	(E)17.4	10.5	1.6	
												(I)19.0				(I)19.8			
9(3)	7/01/73	(51,300)	57,000	A	13.8	149,261*	.90	394	.50	30	163.4	(E)16.2	(E)10.5	7.5	287	(E)28.4	(E)18.4	13.2	G
CT												(I)21.6	(I)14.3			(I)37.9	(I)25.1		G
10(2)	12/14/73	(51,300)	57,000	A	13.8	149,261*	.90	394	.50	30	163.4	(E)16.2	(E)10.5	7.5	287	(E)28.4	(E)18.4	13.2	G
CT												(I)21.6	(I)14.3			(I)37.9	(I)25.1		G
KAHE																			
1 R	4/20/63	(81,600)	96,000	30	14.4	65,620	.85	611	.64	30	150	(E)16.7	10.1	1.5	156	(E)17.4	10.5	1.6	
												(I)19.0				(I)19.8			
2 R	11/01/64	(81,600)	96,000	30	14.4	65,620	.85	611	.64	30	150	(E)16.7	10.1	1.5	156	(E)17.4	10.5	1.6	
												(I)19.0				(I)19.8			
3 R	10/01/70	(85,850)	101,000	30	14.4	57,791	.85	548	.58	30	169	(E)17.5	13.5	8.0	167	(E)17.3	13.4	7.9	G
												(I)24.5				(I)24.3			G
4 R	8/01/72	(90,900)	101,000	30	14.4	57,791	.90	514	.58	30	169	(E)17.5	13.5	8.0	167	(E)17.3	13.4	7.9	G
												(I)24.5				(I)24.3			G
5 R	12/30/74	(134,980)	158,800	30	16.0	92,806	.85	1320	.58	30	165.9	(E)17.7	10.9	5.1	104	(E)11.1	6.9	3.2	
6 R	3/31/81	(134,980)	158,800	30	16.0	92,806	.85	1320	.58	30	165.9	(E)17.7	10.9	5.1	104	(E)11.1	6.9	3.2	

E RATED VOLTAGE TRANSIENT REACTANCE
I RATED CURRENT TRANSIENT REACTANCE
+ REWOUND STATOR INSTALLED DEC. 29, 1955

* INCLUDES COMBUSTION TURBINE
R REHEAT UNIT
CT COMBUSTION TURBINE

++ NEW STATOR INSTALLED NOV. 14, 1956
+++ NEW STATOR INSTALLED MAY 25, 1960
(1) REWOUND STATOR INSTALLED DEC. 31, 1975
(2) GEN. ROTOR REPLACED DEC. 29,1977
(3) GEN. ROTOR REPLACED MARCH, 1978
(4) KW IN PARENTHESES ARE CALCULATED AND DO NOT APPEAR ON NAMEPLATES.

** RETIRED DATE
HON. NO.1 -8/1/68
HON. NO.2 -8/1/68
HON. NO.3 -8/1/68

REVISIONS
DEC. 5, 198
XC. TANNO
CRONKHITE

FIGURE 3.7G
HECO GENERATOR DATA

FILE: GENPP 16-8
COMPUTER FILE: XPHETURB LISTING
HAWAIIAN ELECTRIC CO. INC. - TURBINE DATA

UNIT	NAMEPLATE KW	NORMAL CAPABILITY KW	SPEED RPM	WR2 LB/FT2	TURBINE TYPE	THROTTLE TEMP. F	PRES. PSI-GAGE	STEAM RATES AT CAPABILITY LB/KWH	HEAT RATES AT CAPABILITY BTU/KWH	EXHAUST PRESS. IN. OF HG	SERIAL NUMBER	BLR. MFR.
HONOLULU												
1	10,000	7,500**	1800	81,000	SINGLE	651.4	265	10.89	11,210	1.5	LP3880	B-W
2	10,000	7,500**	1800	81,000	SINGLE	651.4	265	10.89	11,210	1.5	LP8432	B-W
3	10,000	7,500**	1800	81,000	SINGLE	651.4	265	10.89	11,210	1.5	LP12217	B-W
5++	20,000	23,000**	1800	178,200	SINGLE	700.0	430	10.44	11,420	1.5	LP12537	B-W
6	10,000	7,500**	3600	4,540	SINGLE	825.0	650	10.89	11,210	265 PSIG	LP18011	B-W
7	35,000	40,000**	3600	6,730	TANDEM	850.0	650	8.74	9,780	2.0	LP2A7195-1	B-W
				35,400							HP2A7194-1	B-W
8	40,000*	58,000	3600	10,030	TANDEM	950.0	1250	8.95	9,192	2.0	LP10A4395-1	B-W
				32,800							HP10A4394-1	B-W
9	51,600	60,000	3600	42,785	TANDEM	950.0	1250	8.73	9,012	2.0	LP10A7918	B-W
											HP10A7917	B-W
WAIAU												
1	7,500	7,000**	3600	9,870	SINGLE	825.0	650	9.93	10,667	1.5	LP6821-1	B-W
2	15,000	17,000**	3600	25,840	SINGLE	825.0	650	9.34	10,757	1.5	LP1A8454-1	B-W
3	40,000	50,000	3600	6,730	TANDEM	900.0	850	9.07	9,582	2.0	LP5A2339-1	B-W
				35,400							HP5A2338-1	B-W
4	40,000	50,000	3600	6,730	TANDEM	900.0	850	9.14	9,615	2.0	LP5A6344-1	B-W
				35,400							HP5A6343-1	B-W
5	50,000	61,000	3600		TANDEM	950.0	1250	8.55	9,150	2.0	LP13A1792-1	B-W
				45,451							HP13A171-1	B-W
6	50,000	60,000	3600	10,028	TANDEM	950.0	1250	8.30	8,861	2.0	HP13A2267-1	B-W
				35,424							LP13A2268-1	B-W
7	81,590	92,000	3600	76,698	TANDEM	1000/1000	1800	7.02	7,972	2.0	HP-1P13A2907-1	CE
					REHEAT						LP13A2908-1	CE
8	81,590	92,000	3600	76,698	TANDEM	1000/1000	1800	7.02	7,972	2.0	HP-1P13A3048	CE
					REHEAT						LP-13A3049-1	CE
9 (+)	52,700	52,000	3600	149,261***	SINGLE	NA	NA	NA	12,795	1050 F	217724	
10 (+)	52,700	50,000	3600	149,261***	SINGLE	NA	NA	NA	12,795	1050 F	217725	
KAHE												
1	78,680	92,000	3600	17,140	TANDEM	1000/1000	1800	6.86	8,105	2.0	HP13A2516-1	B-W
				59,560	REHEAT						LP13A2517-1	B-W
2	78,680	89,000	3600	17,140	TANDEM	1000/1000	1800	6.80	8,020	2.0	HP13A2703-1	B-W
				59,560	REHEAT						LP13A2704-1	B-W
3	81,600	92,000	3600	61,468	TANDEM	1000/1000	1800	6.70	7,998	2.0	178602	CE
					REHEAT							
4	81,600	93,000	3600	61,468	TANDEM	1000/1000	1800	6.70	7,998	2.0	178831	CE
					REHEAT							
5	129,924	146,000	3600	34,577	TANDEM	1000/1000	1800	6.82	8,020	2.0	HP13A4271	B-W
				102,708	REHEAT						LP13A4272	B-W
6	129,924	146,000	3600	34,577	TANDEM	1000/1000	1800	6.82	8,020	2.0	HP13A4291	B-W
				102,708	REHEAT						LP13A4292	B-W

* 40,000 KW RATED, 50,000 KW MAXIMUM

*** INCLUDES GENERATOR

** HONOLULU PLANT NO. 1 CONSISTING OF UNITS 1, 2, 3, AND 6 HAS A COMBINED TOTAL MAXIMUM GROSS CAPABILITY OF 33,000 KW.

REVISIONS
RETIRED 8/1/68, H5 RETIRED 3/31/82, W1 & W2 RETIRED 12/31/82
H7 RETIRED 12/1/83

\+ COMBUSTION TURBINE AMBIENT CONDITIONS 87 F, 0 ELEVATION NA - NOT APPLICABLE

++ REBLADED HP ROWS 1 THRU 15 AND LP ROWS 21 AND 25 IN 1966

FIGURE 3.7H
HECO TURBINE DATA

HAWAIIAN ELECTRIC COMPANY SYSTEM

CUSTOMER'S GENERATOR AND TURBINE DATA

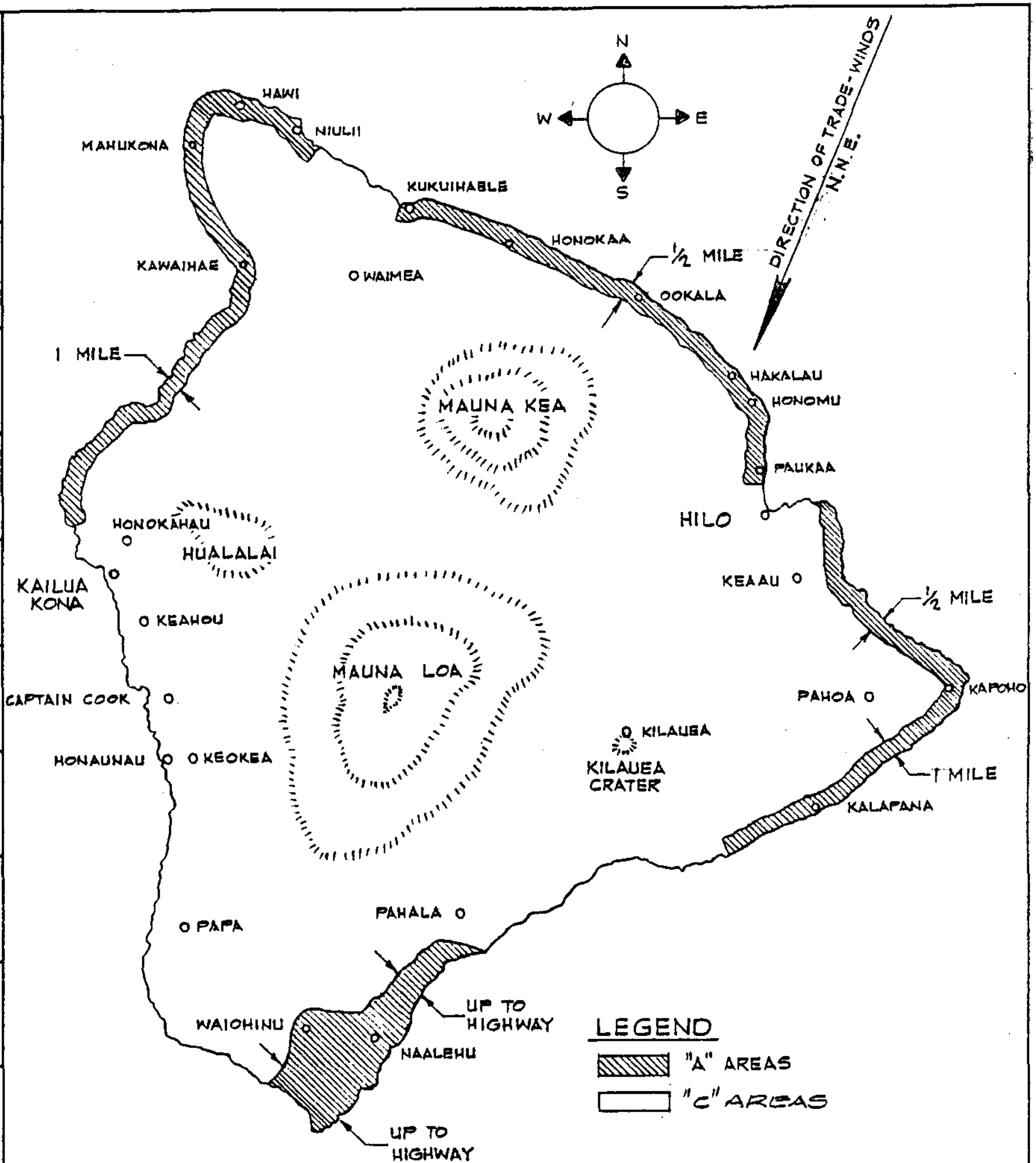
	MAXIMUM NAMEPLATE RATING		SPEED	RATED		GEN. WR2	TUR WR2	GEN	PERCENT ON RATED VOLTAGE NAMEPLATE KVA BASE				PERCENT ON RATED LV 100 MVA BASE			
	KW	KVA	RPM	KV	P.F.	LB-FT2	LB-FT2	SCR	XD	X'D	X"D	Xo	XD	X'D	X"D	Xo
OAHU SUGAR	4,500	5,000	3,600	11.5	0.8	3,250	7,830	1.01	125.0	16.1	8.1	0.9	2500.0	322.0	162.0	18.0
	12,500	15,625	3,600	11.5	0.8	10,787	11,631	0.77	149.0	17.0(I)	9.5	9.5	953.6	108.8(I)	60.8	60.8
										14.0(E)				89.6(E)		
WAIALUA	++2,000	2,500	3,600	12.0	0.8	1,600	1,350	1.08	100.0	14.3	8.3	3.6	4060.0	568.0	328.0	148.0
	9,375	12,500	3,600	12.0	0.8	8,060	9,090	0.79	144.0	21.4	13.0	6.97				
C&H Aiea	988	1235	3,600	.48	0.8	1,250	3,940		130.0	20.0	11.9	13.4	5200.0	800.0	476.0	536.0
HIRI	24,000	29,450	3,600	13.8	0.8	16,660		1.00	248.0	24.2	17.7	19.5	830.4	81.0	59.3	65.3
HERS WF	9,000			4.16												
MOD-5B	3,200			4.16												
HRRP	64,470	75,000	3,600	13.8	0.80	31,857	38,038		183.2	28.5	24.6	12.7	244.3	38.0	32.8	16.9
Kalaeloa CT1	101,320	119,200	3,600	13.8	0.85	312,159	<---		267.0	28.4	22.2	9.7	224.0	23.8	18.6	8.1
CT2	101,320	119,200	3,600	13.8	0.85	312,159	<---		267.0	28.4	22.2	9.7	224.0	23.8	18.6	8.1
ST	52,351	61,590	3,600	13.8	0.85	82,291	<---		173.4	19.2	14.6	6.7	281.5	31.2	23.7	10.9
AES	153,600	192,000	3,600	16.0	0.85	168,201	<---		191.0	22.0	18.0	11.0	99.5	11.5	9.4	5.7

1 RATED CURRENT TRANSIENT REACTANCE
E RATED VOLTAGE TRANSIENT REACTANCE
* DELTA CONNECTED
** STANDBY
+ NON-OPERABLE
++ EMERGENCY STANDBY

REVISION
APRIL 7, 1978
JULY 24, 1984
APRIL 21, 1989

DSGENERA

FIGURE 3.71
HECO CUSTOMER DATA



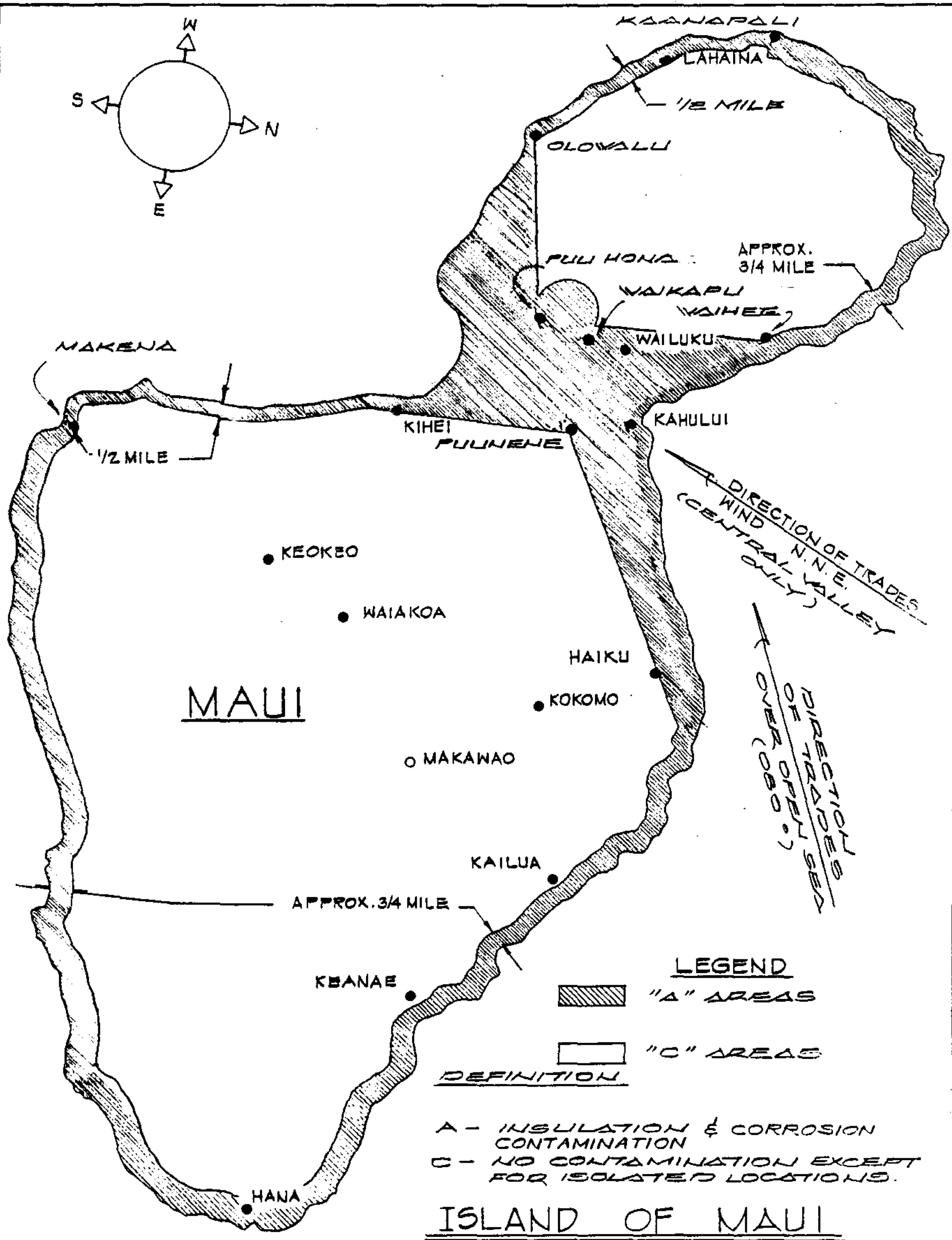
DEFINITION:
A - INSULATION & CORROSION CONTAMINATION
C - NO CONTAMINATION EXCEPT FOR ISOLATED LOCATIONS

ISLAND OF HAWAII

DRAWN AG	DESIGNED GKQ	APPD.
SUPERSEDES		INSULATION AREAS ENGINEERING DATA
STANDARD CONSTRUCTION HAWAIIAN ELECTRIC CO. INC.		

REVISION | DATE | INITIAL

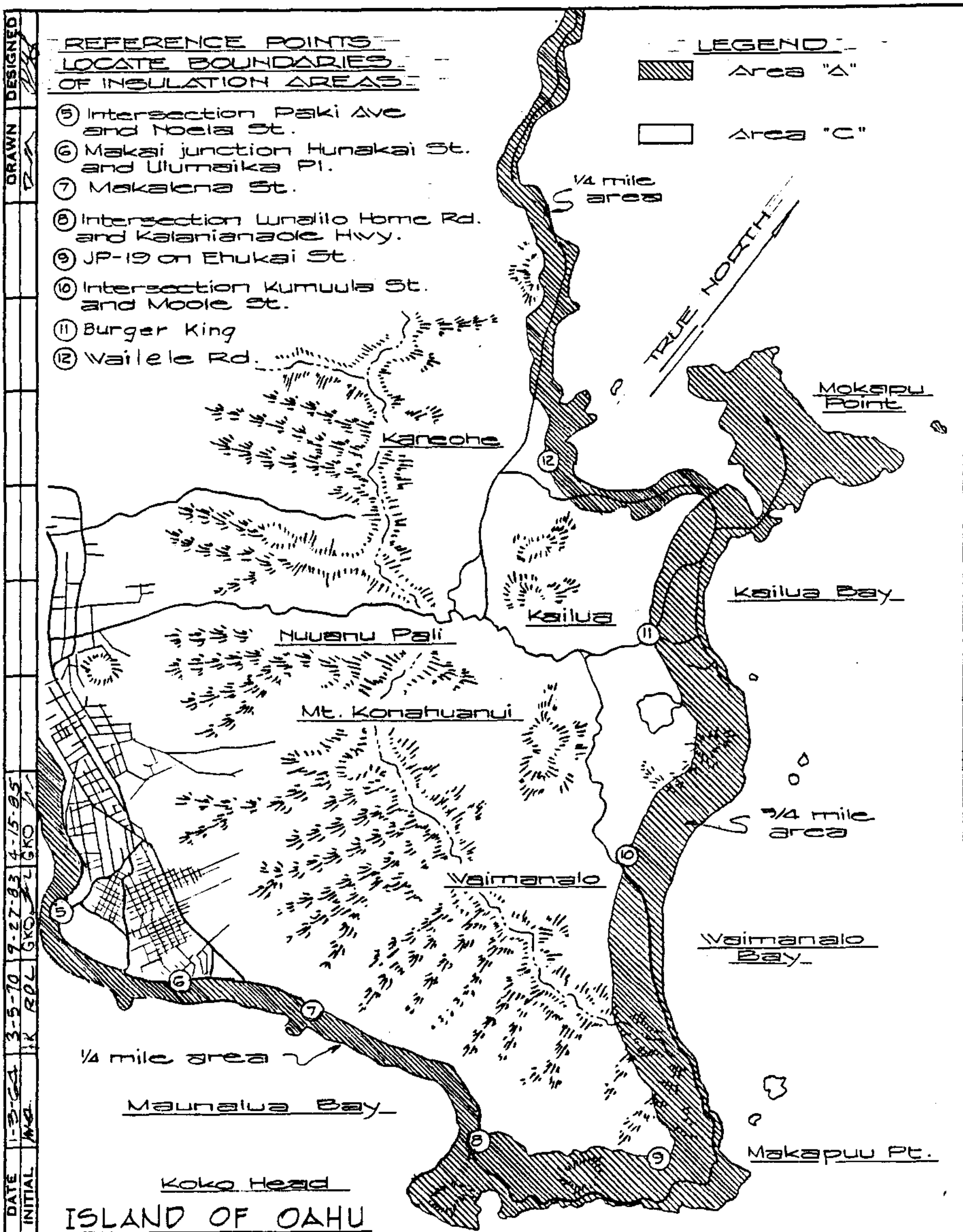
FIGURE 3.7J HAWAII INSULATION AREAS



REVISION	DATE	INITIAL
	8-27-76	CKO

DRAWN D.T.	DESIGNED	APPD. RDL		REDRAWN
SUPERSEDES	INSULATION AREAS			
STANDARD CONSTRUCTION HAWAIIAN ELECTRIC CO. INC.	ENGINEERING DATA			

FIGURE 3.7K MAUI INSULATION AREAS



INSULATION AREAS

ENGINEERING DATA

APPD.

STANDARD CONSTRUCT

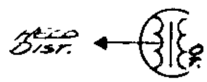
THE HAWAIIAN ELECTRIC C

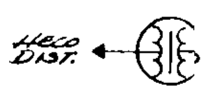
SHE

**FIGURE 3.7L
OAHU INSULATION
AREAS**

NOTES:

1. ALL 138KV BREAKERS TO BE RATED 2000 AMPS CONTINUOUS, 40KAIC AT 145KV.
2. ALL 138KV DISCONNECTS TO BE 2000 AMPS.
3. 138KV BUS TO BE DESIGNED FOR 2000 AMP CONTINUOUS, 40KAIC AT 145KV.
4. SEE SHEET 2 OF 2 FOR TYPICAL RELAYING.
5. IP INDICATES INTERCONNECTION POINT.
6. ALL 138KV CT'S ARE 2000/5Y.
7. ALL 138KV LINES ARE 2000 AMPS.





NO	DATE	REVISIONS	BY	CHK'D	APP'D

PRELIMINARY SLD
ANIANI SUBSTATION FOR
GEOTHERMAL INTERCONNECTION

DESIGNED	DRAWN	DATE 2/10/89	SCALE
CHECKED ELEC. MECH. STR.			
APPROVAL PMO			

FIGURE 3.8A
PRELIMINARY ANIANI SINGLE LINE DIAGRAM

CHAPTER 4: RELIABILITY

The HECO system serves the island of Oahu. Because of its isolation, there are no interties between the HECO system and any other electric power system. This unique situation requires reliability factors and operating practices not ordinarily found in more conventional interconnected electric systems.

4.1 SYSTEM CHARACTERISTICS

The island environment requires HECO to operate its system with sufficient spinning reserve so that the inadvertent loss of the most heavily loaded unit will not result in the loss of power to any customer. The units on spinning reserve must react quickly and restore the system frequency to at least 58.5 Hz upon loss of the most heavily loaded unit. The amount of spinning reserve with quick response time (that which can be achieved in three (3) seconds) is defined as "quick load pick-up" by HECO.

The maximum sized unit currently on the HECO system has a normal top load of 142 MW. This is the maximum amount of spinning reserve HECO intentionally has synchronized to the system.

The variation in load during a 24 hour period requires that cycling units be taken off-line during the off-peak hours, presently 9:00 pm to 7:00 am. The HECO Load Dispatcher directs this operation. Further, base-loaded units are designed to have the capability of reducing load to about one-half of rated capacity. It would be highly desirable that the Project be capable of meeting similar operating requirements.

4.2 HECO RELIABILITY

The island environment demands a high reliability from existing HECO generating units. Typically, the annual forced outage rate for all generating units ranges from a low of two percent to a high of four percent. The equivalent availability factor runs between 90 percent and 92 percent.

The average service availability index (ASAI) is a measure of the reliability of the HECO distribution system. The ASAI is defined as the average number of customers (#) on the HECO system times the period hours (PH) minus the customer hours lost (CHL) divided by the average number of customers times the period hours. Mathematically, the ASAI is expressed as follows:

$$\text{ASAI} = \frac{(\#) \times (\text{PH}) - (\text{CHL})}{(\#) \times (\text{PH})}$$

From 1984 to 1988, the annual ASAI on the HECO distribution system has ranged from a low of 99.951 percent to a high of 99.983 percent.

4.3 ASSUMPTIONS AND CONSIDERATIONS

It is anticipated that the DEVELOPER will install capacity in increments of between 25 MW and 50 MW. Ideally, the Project capacity will be brought on-line to match HECO's needs. Such a schedule is likely to enhance and optimize the value of the Project's capacity.

It is suggested that the size of the largest geothermal generating unit not exceed about 125 MW. This is smaller than the HECO largest unit of 142 MW. However, such an increment will ensure that HECO spinning reserve and quick load pickup will be adequate to cover the loss of the largest Project generating unit or loss of one component of the HVDC transmission system.

The reliability of the power delivered to HECO will be measured at the point of interconnection to the HECO grid (see Section 3.8).

4.4 RELIABILITY ASSESSMENT

For the purpose of calculating reliability, the Project is defined as all components involved in the generation and delivery of electrical power to the point(s) of interconnection. This includes, but is not limited to, the geothermal wells, the wellfield(s), turbine generators, switchgear, substation(s), overhead transmission lines, submarine cables, and converter terminals. The higher the Project reliability, the more valuable this capacity will be to the HECO system.

The following indices of the Project reliability and availability must be provided in the Proposal:

a. Forced Outage Rate (FOR)

b. Equivalent Forced Outage Rate (EFOR)

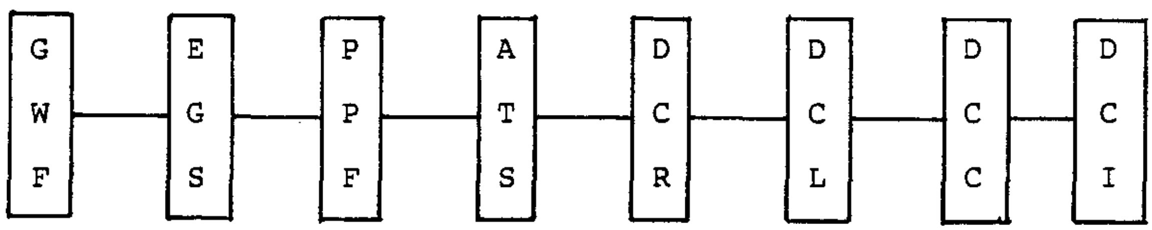
c. Availability Factor (AF)

d. Equivalent Availability Factor (EAF)

HECO will use the Electric Power Research Insitute UNIRAM availability assessment methodology to evaluate the reliability of the proposed design. Information on UNIRAM can be found in Reference 1.

The above indices shall be defined and calculated in accordance with ANSI/IEEE Standard 762 (Reference 3). The equations and definitions found in ANSI/IEEE Standard 762 are used by the North American Electric Reliability Council (NERC) in the Generating Availability Data System (GADS) to produce generating unit statistics and generating unit availability reports.

Equipment and system configuration information sufficient to verify and validate these measures must be provided in the form of availability block diagrams and fault tree diagrams compatible with the UNIRAM availability assessment methodology. An example of an availability block diagram at the Project element level to be used in the reliability and availability calculations is shown below:



GWF - Geothermal Wellfield
EGS - Energy Gathering System
PPF - Power Production Facilities
ATS - AC Transmission System

DCR - DC Rectifier
DCL - DC Line
DCC - DC Cable
DCI - DC Inverter

Each major block should be broken down into identifiable components or group of components, each component to be assigned a mean time between failures (MTBF) and a mean down time (MDT) based on the PROPOSER'S experience with that component. For example, the converter terminals should use the following breakdown as a minimum:

AC Filter
AC Switches
AC Circuit Breakers
AC Surge Arresters
Converter Transformers
Valve Control
Thyristers
DC Surge Arresters

Smoothing Reactors
DC Filters
Neutral Bus Filters
Neutral Bus Switches
Ground Return
Cooling System
Auxiliaries

This information should be submitted in the form of input data files to the UNIRAM version 2.0 program on a hard copy and either 3.5-inch (720 KB or 1.44 MB) or 5.25-inch (360 KB) floppy disks formatted for the IBM Personal Computer.

It is expected that equipment MTBF and MDT statistics for all components used in support of the Proposal will correspond to utility records available in the NERC GADS and other sources such as PROPOSER experience, International Conference on Large High Voltage Electric Systems (CIGRE) reports, and the Edison Electric Institute (EEI) reports. Any statistics used in support of the Proposal that are significantly different from those in GADS (see Reference 2), or other published sources, should be accompanied by verifiable evidence. In addition, values for scheduled outage hours and rolling maintenance should also be supported by verifiable evidence for purposes of evaluating availability factors and equivalent availability factors.

4.4.1 GEOTHERMAL WELLFIELD RELIABILITY

Geothermal wellfields in the KERZ probably represent the least known factor in the information available for this Project. An adequate data experience matrix for an assessment of reliability of KERZ geothermal wells will likely come only out of KERZ multiple well production history. At inception, wellfield reliability can be addressed by selecting a energy producing capacity in excess of the connected electrical generating capacity. The magnitude of excess energy producing capacity should be based on PROPOSER'S integration of estimated well deliverability, well cost, actual electrical generation requirements and power pricing mechanisms. PROPOSER should, however, include corrosion/erosion effects on wellfield equipment in the reliability calculations. PROPOSER should also include in the reliability evaluation the potential impacts of lava flows and earthquakes on the wells.

4.5 PROJECT SYSTEM RELIABILITY REQUIREMENTS

Based on HECO's overall system reliability requirements, the maximum allowable loss of Project power is about 125 MW. This is independent of whether the loss is in the geothermal wellfield, the electric power production facilities, a major converter terminal component, (e.g. a converter transformer, smoothing reactor, or valve), a cable or transmission structure.

Proper interpretation of this requirement depends on the amount of Project power being delivered to HECO and the duration of any outage. For example, assuming a three cable system and the delivery of 500 MW, there could be a loss of 250 MW for the length of time required for cable switching if the cable failure occurred on the pole with the paired cable. This would exceed the 125 MW loss criteria.

The complexity, redundancy and cost of the Project will likely be dependent on the reliability required. HECO would like to obtain comparative costs for the systems designed to different reliability criteria. Thus, the Proposal should include information for the following four cases:

Case	Power Delivery (MW)	Power Loss (MW)
1	125	125
2	500	125
3	500	250
4	500	500

Case 1 represents the first phase of the Project, that increment of power to be delivered in 1995. Case 2 represents the complete Project as discussed throughout this RFP. Cases 3 and 4 represent the Project with a lesser reliability.

Information on the calculated costs and reliability for the four cases should be presented on Exhibit 4.5A. The project design will very likely be different for the four cases. Exhibit 4.5B requests a descriptive comparison of the four designs. Costs for Cases 1 and 2 are requested in Section 7.1, Exhibits 7.1A, B and C. The equivalent exhibits should be provided for Cases 3 and 4 as Exhibit 4.5C and 4.5D, respectively.

Proposer should also submit the reliability data to be used in the UNIRAM assessment methodology that support the above analysis.

4.6 REFERENCES FOR CHAPTER 4

1. Electric Power Research Institute. User's Guide for the UNIRAM Availability Assessment Methodology: Version 2.0. EPRI Report AP-5897-CCM.

   Reference 1 is available from Research Reports Center, Box 50490, Palo Alto, California 94303, (415) 965-4081. Required software is available by contacting Larry Coit, Electric Power Research Insitute, P.O. Box 10412, Palo Alto, CA 94303, (415) 855-8972. Please refer to the Hawaii Geothermal/ Interisland Transmission Project when contacting EPRI.

2. North American Electric Reliability Council. Generating Availability Reports, various years.

   Reference 2 is available from the North American Electric Reliability Council, 101 College Road East, Princeton, NJ 08540-6601. Telephone 609-452-8060.

   A listing of all system/component cause codes within each major equipment group can be found in Appendix B of the NERC GADS Data Reporting Instructions.

3. American National Standards Insitute. IEEE Standard Definitions for Use In Reporting Electric Generating Unit Reliability, Availability, and Productivity (1987). ANSI/IEEE Standard 762.

CHAPTER 5: POWER DELIVERY AND SCHEDULE

The delivery of Project power to HECO will be determined by its need for power and the rate of development of the geothermal resource. This Chapter describes HECO's forecasted power requirements and the scheduling information to be included in the Proposal.

The Project can provide HECO with both capacity and energy. HECO will require additional baseload and cyclable capacity after 1994. The amount of baseload capacity that HECO could accept is determined by the minimum load on the system and that portion of this minimum load reserved for generation on Oahu. The amount of deliverable capacity in excess of this minimum is dependent upon the DEVELOPER's ability to cycle the Project. Depending on the time of day, HECO could agree to accept up to the full 500 MW Project capacity.

HECO will accept the energy represented by the PPA capacity. The amount of additional energy that HECO could absorb depends on the system load. The PROPOSER has the option of varying the Project's design and development to maximize the sale of capacity and energy to HECO.

5.1 CAPACITY

HECO's present (spring, 1989) system capacity is 1277 MW. The system's peak load is growing by about 2.2 percent per year. Purchases from Independent Power Producers are expected to accommodate this growth through 1994. HECO has to begin planning additional capacity by the end of 1990 to accommodate the post-1994 growth. Hence the timing for this RFP.

HECO's capacity requirements beyond 1994 are dependent on the amount of installed generation, load growth, unit retirement and level of acceptable risk. Risk, as defined by HECO, is a probabilistic index which indicates the probability of having insufficient capacity to meet the peak demand for the day. HECO uses a minimum acceptable risk index of 4.5 years per day, which may be restated as having insufficient capacity to meet the peak demand for one day out of every 4.5 years.

The estimated capacity requirements are shown on Figure 5.1A as a step function based on 25 MW increments of generatin addition. This estimate has been prepared for only the ten year period of 1995 to 2005, during which HECO plans to add approximately 500 MW.

Superimposed on the HECO capacity requirements is a hypothetical Project power supply capability curve, shown as a smooth curve for clarity although it most likely would be a step function. As can be seen, this hypothetical uniform development of the Project results in an excess of Project capacity in the years up to 2001, after which a shortfall exists until the full 500 MW capability is on line.

The PROPOSER has other options. Referring to Figure 5.2A, the Project could install 230 MW of baseload capacity by 1995. With respect to baseload capacity demand after 1995, the Project could then add baseload capacity only if HECO experiences an increase in minimum load beyond that which is currently anticipated. However, if any portion of the Project power can be cycled, additional cycling capacity (beyond additional baseload) can be added up to the full 500 MW Project development. The reliability of delivery must be consistent with HECO's maximum loss of generation criteria of about 125 MW, see Chapter 4.

5.2 ENERGY

Forecasted peak and minimum HECO annual loads are shown on Figure 5.2A. The beginning point for PPA negotiations for power delivery will be the curves presented in this section.

5.2.1 PEAK LOAD

Peak loads for HECO are expected to increase from the present level of 1080 MW to about 1660 MW in 2008, assuming a steady growth rate of 2.2% per year. There should be no constraint on sale of Project power at peak load levels, as can be seen in Figure 5.2A.

The PROPOSER may assume that any amount of Project power in excess of the level absored by HECO at minimum load (see Section 5.2.2) will be purchased by HECO as peaking power when such power is delivered during on-peak periods. On-peak hours are presently 7:00 am to 9:00 pm.

5.2.2 MINIMUM LOAD

Minimum load growth on Oahu is estimated to continue at a rate of 1.6% per year. This is shown on Figure 5.2A, along with another curve that is offset by 230 MW. This 230 MW is HECO's judgment as to the minimum generation that must be maintained on Oahu, accounting for contractual commitments and HECO's generation needed to stabilize the system. This assumes that HECO's reheat units will be modified to maximize their cycling capability by 1995.

This lower curve of Figure 5.2A represents the amount of Project power that HECO could absorb during minimum load conditions. It could be considered the potential baseload for the Project. Also shown on Figure 5.2A is the same hypothetical Project power supply capability used on Figure 5.1A. As can be seen, HECO could absorb more than the hypothetical Project capability from the initiation of power delivery through the year 2000. In fact, at minimum load HECO could absorb approximately 230 MW in 1995, rising to about 250 MW in the year 2000. HECO cannot absorb all the potentially available Project power at minimum load from approximately the year 2001 through the year 2020.

The PROPOSER should strongly consider and describe methods of reducing Project power flow to HECO during light load periods and other possible situations when HECO will require less power than would be available from the Project. Refer to Section 7.1.2 for further discussion on this subject.

5.2.3 DAILY AND YEARLY VARIATIONS

The previous RFP sections present only the instantaneous peak and minimum demand on the systems. The amount of power that can be cycled is determined by the daily and yearly variations. Figure 5.2B presents HECO daily variations for four conditions, February and August weekdays and weekends. Information on HECO yearly variations can be determined from Tables 5.2A, B and C.

5.3 PROPOSED SCHEDULE

Sections 5.1 and 5.2 present HECO's best assessment of its capability to accept power from the Project using the assumptions for Project development stated and HECO's present forecast for load growth, new generation units on order, unit retirement schedule and modification of reheat units for cycling duty. The PROPOSER should consider this information in the preparation of the Proposal. However, if the information with its assumptions adversely affects or influences the economic feasibility of the Project (c.f. Section 7.1.6), the PROPOSER should identify the problems and propose an alternate schedule. The PROPOSER is strongly urged to use HECO's capacity and energy requirements shown on Figures 5.1A and 5.2A if at all possible.

Several times throughout the RFP reference is made to a first phase of Project power of about 125 MW. This is only an assumption for purposes of describing the first phase. The PROPOSER is free to select a different value. The PROPOSER should complete Exhibit 5.3A for whatever power delivery schedule is used in the Proposal, for the first phase and the complete Project. These values of Exhibit 5.3A should also be used for all other Proposal submittals.

HECO requires schedule-related information to validate commitments made by the PROPOSER. This should be in the form of a milestone or summary schedule. HECO is not specifying the exact form this schedule should take, as it will vary with PROPOSER'S scheduling software computer program and the exact mix of Project equipment proposed. However, the timeline should include, as a minimum, the information on the sample Exhibit 5.3B included in the RFP. One Exhibit 5.3B should be included for the first phase of power shown on PROPOSER'S Exhibit 5.3A, and one for the complete Project. The amount of detail shown on the Project exhibit can be less than that shown for the first phase exhibit.

This milestone schedule should include all steps necessary to obtain access to and permission to use the geothermal resource, acquire the necessary surface rights and rights of way and secure permits for the major elements of the project. Specification preparation, procurement, fabrication and installation should be specifically included for at least the major items, as shown on the sample Exhibit 5.3B. PROPOSERS may include more items, if desired. Major civil and structural construction activities should also be shown, as well as testing and start-up.

The PROPOSER is encouraged to present a qualitative/quantitive defense of PROPOSER'S Exhibits 5.3B on Exhibit 5.3C.

MORNING

HAWAIIAN ELECTRIC CO., INC., RECORDED INSTANTANEOUS PEAK MEGAWATT DEMAND BY MONTHS - AM

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
JAN	813	818	818	822	862	833	876	897	947		
FEB	821	840	835	844	861	851	875	879	944		
MAR	804	812	804	855	868	825	895	894	947		
APR	801	817	808	838	846	842	888	890	941		
MAY	835	827	834	840	856	844	894*	942*	969		
JUN	848	855*	865*	860*	873*	889*	915*	973*	990*		
JUL	852	866*	893*	865*	868*	918*	957*	992*	992*		
AUG	855	881	886*	891*	880*	924*	976*	987*	1031*		
SEP	872	884	894	881	887	912	963*	1006	1031		
OCT	869	861	868	872	900	907	951	994	1014		
NOV	853	850	869	878	883	906	938	989	1011		
DEC	864	844	876	865	846	901	927	955	1000		

* AM PEAK EXCEEDS PM PEAK

TABLE 5.2A
YEARLY MORNING
PEAK DEMAND

AFTERNOON

HAWAIIAN ELECTRIC CO, INC., RECORDED INSTANTANEOUS PEAK MEGAWATT DEMAND BY MONTHS - PM

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
JAN	883	914	919	903	889	898	927	891	923	963	993
FEB	873	890	901	906	890	906	925	908	918	937	995
MAR	887	884	883	875	857	895	901	865	920	930	981
APR	869	877	863	860	847	868	875	864	896	914	945
MAY	858	877	867	848	857	866	862	846	882*	904*	971
JUN	840	855	858	849*	863*	845*	853*	862*	886*	940*	962*
JUL	867	867	874	863*	872*	859*	852*	906*	927*	955*	963*
AUG	887	907	869	885	879*	887*	852*	902*	929*	975*	997*
SEP	900	910	931	905	916	914	891	921	956*	1016	1035
OCT	911	953	935	903	928	925	935	938	971	1018	1035
NOV	917	928	938	920	932	939	925	940	986	1030	1065
DEC	903	939	926	918	915	944	908	943	968	1014	1068

* AM PEAK EXCEEDED PM

TABLE 5.2B
YEARLY AFTERNOO
PEAK DEMAND

HECO

RECORDED INSTANTANEOUS MINIMUM MEGAWATT DEMAND BY MONTHS

JAN	377	407	419	434
FEB	378	401	421	449
MAR	394	416	419	456
APR	390	409	416	454
MAY	388	429	417	470
JUN	406	422	457	489
JUL	429	461	477	506
AUG	432	462	493	503
SEP	438	466	493	500
OCT	431	451	483	494
NOV	404	431	459	503
DEC	401	422	451	458

TABLE 5.2C
YEARLY MINIMUM DEMAND

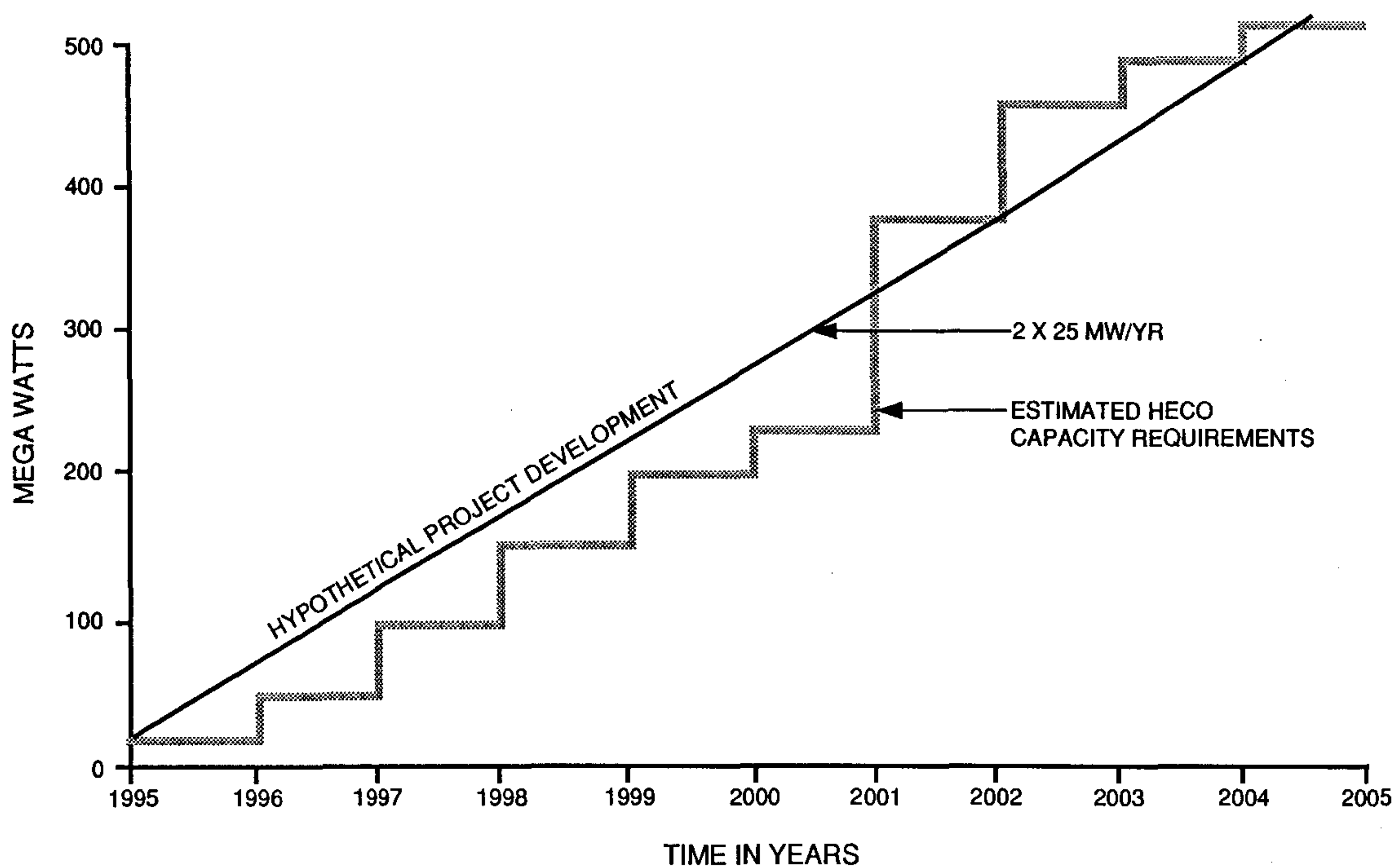
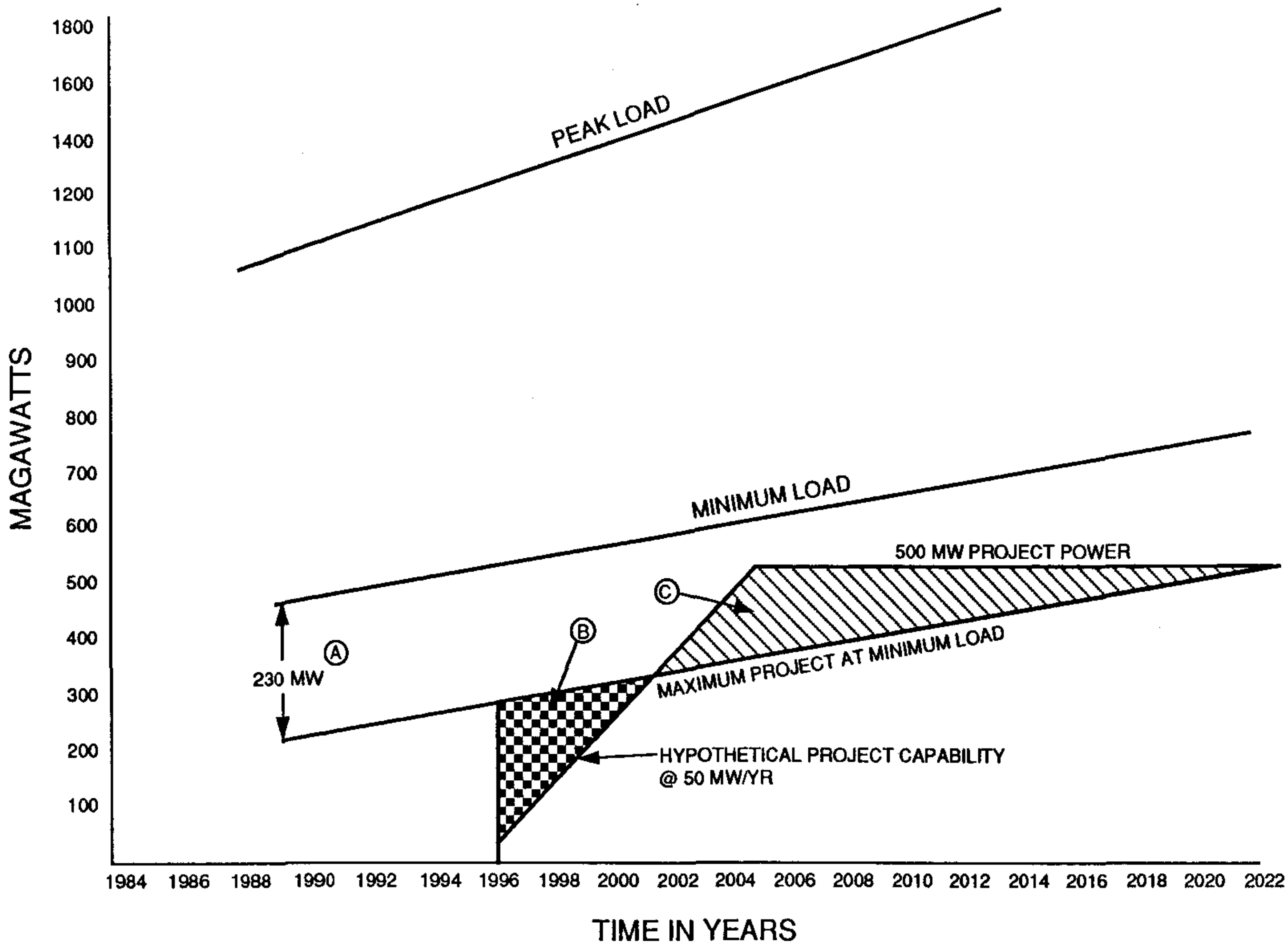


Figure 5.1A
CAPACITY CONSIDERATIONS

M0489079



NOTES

Ⓐ 230 MW REPRESENTS MINIMUM HECO GENERATION AT MINIMUM LOAD

Ⓑ AREA REPRESENTS ADDITIONAL PROJECT POWER WHICH COULD BE ABSORBED BY HECO

Ⓒ AREA REPRESENTS EXCESS PROJECT POWER AT MINIMUM LOAD

M0489078

Figure 5.2A
ENERGY CONSIDERATIONS

HECO

1989 Adjusted Load Profile

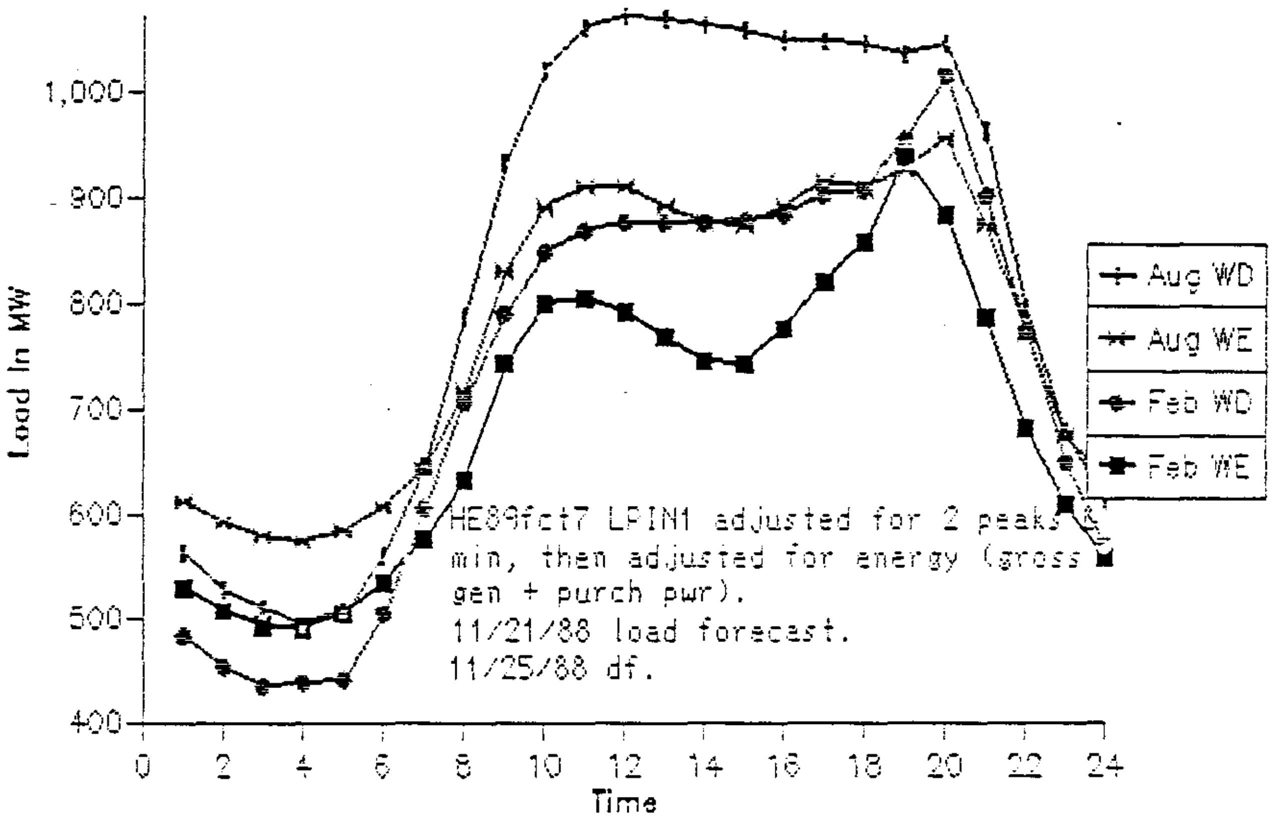


FIGURE 5.2B
DAILY LOAD VARIATION

CHAPTER 6: PERMIT AND ENVIRONMENTAL INFORMATION

The State of Hawaii Department of Business and Economic Development has prepared a summary of available permit and environmental information that they believe is applicable to this Project. This is included in the RFP as Appendix B.

6.1 PERMITS

The Proposal shall identify all state, federal and local permits required or which may be required in order to successfully complete all stages of the Project. The Proposal shall also provide estimates of the time required to obtain each permit and shall state the basis for such estimates. The PROPOSER should account for the public hearing requirements when developing the permitting timeline. The Proposal shall also discuss the effect of the timing of the permit process on the ability of the DEVELOPER to deliver power from the Project in a timely fashion, consistent with the requirements for power described elsewhere in this RFP. Each major "milestone" in the state and federal permitting process should be included in the Exhibits 5.3B (See Section 5.3).

Appendix B.1 is a summary, prepared by the State of Hawaii, which sets forth the State's current understanding of the permitting regimes likely to apply to the Project. This summary is intended as guidance and is not intended to relieve the PROPOSER of the responsibility to conduct an independent analysis of the permitting regime applicable to the Project. Although this summary is as thorough as possible to provide maximum assistance to the PROPOSER, HECO makes no representations that Appendix B is a complete list of necessary permits, and makes no warranty with respect to legal issues arising under the laws and regulations discussed therein.

The Governor of Hawaii has offered the State's assistance in obtaining permits. See Governor Waihee's letter to H.D. Williamson (attached following the Executive Summary). This offer by the State does not relieve the PROPOSER from identifying the permit requirements and schedule in the Proposal.

6.2 ENVIRONMENTAL INFORMATION

Available environmental information will be assembled in the public document room for review by interested Proposers.

The PROPOSER should indicate in the Proposal whether any environmental, cultural or socioeconomic issues materially affect the planning of essential aspects of the Project. The Proposal should include a plan, with a schedule, for fully analyzing and addressing these issues.

Appendix B.2 is a summary, prepared by the State of Hawaii, of the available environmental information.

CHAPTER 7: COMMERCIAL INFORMATION

7.1 FINANCIAL PROJECTIONS

This section describes the financial projections requested of the PROPOSER. These projections will be a major factor in HECO's evaluation of the Proposal. For purposes of this section, financial projections include both the PROPOSER'S pricing proposals to HECO and the Project costs used to determine the Project's financial feasibility.

All recipients of this RFP who posses the technical, managerial and financial expertise to develop this Project are strongly urged to submit a Proposal. HECO is interested in receiving a wide variety of approaches to this Project development. To this end, HECO will evaluate each Proposal received. Projected costs of the Project's power are just one factor in the evaluation, albeit a major one.

7.1.1 AVOIDED COSTS

Power purchase agreements entered into by HECO have been based on some form of avoided cost. Avoided costs typically have two components, a capacity payment and an energy payment, occasionally varying with the time of day and season of the year. HECO's latest avoided cost filing was in late 1988. It is included here as Attachment 7.1A.

HECO does not intend that the current avoided cost formula will dictate the pricing formula for this Project. The pricing terms of any PPA entered into for this Project will be based on a power cost formula developed specifically for this Project, taking into account its unique character. This Project represents a much larger block of power than HECO has considered in the past. It also has very unique characteristics compared to those power sources available to HECO now or in the near-term future. State policy considerations may affect the cost formula. (See Governor Waihee's letter attached following the Executive Summary.) The costs to HECO of alternative sources of power, however, will affect HECO's evaluation of the Proposals submitted in response to this RFP.

The following sections ask for detailed cost information so that HECO may fully evaluate the Proposals and to provide a starting point for the financial portion of the negotiations that will lead to a PPA.

7.1.2 PROJECT SCENARIOS

From HECO's standpoint, the ideal power source is as described in Section 1.3. It should be highly reliable and fully dispatchable, i.e., available in the quantities and only in the quantities that HECO requires at any moment. Both qualities may increase the effective cost of the Project's power, but may also increase the value of that power to HECO.

HECO strongly invites PROPOSERS to investigate and propose means for maximizing reliability and dispatchability. For example, if the PROPOSER can find a load leveling use of geothermal resources, it could increase the DEVELOPER'S revenue and may increase dispatchability and reliability of the power made available to HECO. If such a load leveling use involves the sale of power, such power sales shall be only to HECO.

PROPOSERS are asked to present in some detail all scenarios that they may have developed in preparing their Proposal. Letters or memoranda or documentation of a similar nature should be presented to support the validity of the scenario. Because such documentation may be highly confidential, the PROPOSER may choose to provide information at the Proposal stage which does not identify the party or parties to such actual or anticipated agreements (c.f. Section 2.7). However, HECO will require all pertinent information be available as a basis for negotiation.

In the financial analyses requested in the following sections, PROPOSERS should present as a base case the Project costs for a stand-alone Project. Additional exhibits should then be used to show the costs to HECO from a Project developed under an alternative scenario. PROPOSER is strongly urged to present all scenarios developed in the course of preparing the Proposal. A scenario that may not in PROPOSER'S eyes be the most cost-effective may have facets that may make it more valuable to HECO than the PROPOSER may realize. (The State of Hawaii may also have an interest in such alternate scenarios).

7.1.3 GEOTHERMAL RESOURCE COSTS

The financial exhibits which follow request capital costs and operating and maintenance expenses for the geothermal wellfields. As discussed in Section 3.1.6, HECO anticipates that PROPOSERS may not have access to the geothermal resources prior to submittal of the Proposal. HECO does not intend to consider in the evaluation the ownership or lease related costs so as to evaluate all Proposals on an equivalent basis and thereby maintain a competitive environment for this Project.

HECO, however, does not wish to preclude any PROPOSER from reaching accommodations with any major geothermal mineral leaseholder or surface owner. If the PROPOSER has secured options or letters of intent for sufficient geothermal resources, that should be identified. HECO also does not require that a Proposal include an exclusive right to an individual geothermal mining lease. The same lease interest could be represented in many different Proposals.

HECO plans to normalize the geothermal costs between Proposals. There are spaces on both the capital and operations and maintenance exhibits for geothermal ownership or lease related costs. These should be completed if possible. HECO has available to it extensive geothermal exploration and production cost information. This information will be used to evaluate any information provided in the Proposal.

Proposals should include drilling and maintenance costs, regardless of whether PROPOSER has an ownership or lease resource position.

PROPOSERS must begin negotiations to obtain access to sufficient geothermal resources if they are selected to the short list. HECO will not sign a PPA unless the DEVELOPER has obtained access to the geothermal resource. HECO may cooperate in efforts to obtain geothermal resource rights, as appropriate. The State also has a very high interest in the utilization of the State-issued geothermal leases for the Project.

Attachments 7.1B and 7.1C are letters from existing geothermal leaseholders. They contain information which HECO believes may be of interest to PROPOSERS in preparing responses to the RFP. This material has been included in the RFP solely for purposes of information. HECO in no way endorses or warrants the information contained in these materials, nor should the inclusion of these materials in the RFP be construed as a request by HECO that the statements by third parties contained in these materials be taken into consideration in the preparation of a response to the RFP.

7.1.4 CAPITAL COSTS

The estimated capital cost of the Project is to be based on development of the complete system: geothermal wells, injection wells, energy gathering and waste disposal systems, power production facilities, overland transmission lines, submarine cables, converter terminals and any other equipment and facilities that may be required. The PROPOSER is requested to present capital costs as a function of time. The PROPOSER should use Exhibit 7.1A to present this information.

This exhibit is a condensation of the National Association of Regulatory Utility Commissioners (NARUC) code of accounts. (This code of accounts is essentially identical to the Federal Energy Regulatory Commission code of accounts.) The format of Exhibit 7.1A is being used so that HECO may compare Project costs with other data available to HECO.

A separate Exhibit 7.1A should be provided for the first phase of the Project as well as for the complete Project. The first phase is defined as that increment of power which will be available by December 1995. There will likely be an overlap between the first phase and later phases, and HECO desires to clearly understand the PROPOSER'S plans for the first phase. An Exhibit 7.1A should be provided for the base Proposal (stand-alone Project) and also for each individual scenario considered by the PROPOSER.

Exhibit 7.1A is based on an escalation rate of five percent/year, compounded. PROPOSERS may include additional Exhibits if they believe that this escalation rate is inappropriate. The PROPOSER is encouraged to footnote the analyses to clarify portions which may be unclear.

The Proposal should also provide the assumptions, data, and algorithms used in constructing financial statements (examples: inflation rates, interest rates, depreciation schedules, utilization rates and product prices) in sufficient detail to allow HECO to replicate the financial pro formas submitted. This information should be provided for Exhibits 7.1A, B and C.

PROPOSERS who are unfamiliar with the NARUC code of accounts should refer to Reference 1. A copy of this document is in the public document room. If, upon review, questions remain, they should be submitted under the procedures described in Section 2.2.

7.1.5 OPERATION AND MAINTENANCE COSTS

The operation and maintenance (O&M) costs should be provided for the entire Project. Drilling of replacement production and injection wells, as well as reworking wells, should be treated as an O&M cost. There should also be specific allowances for the energy gathering system, power production facilities, overland and submarine transmission, converter terminals and any other equipment or facilities costed on Exhibits 7.1A.

The PROPOSER is requested to present O&M costs as a function of time in the format provided in Exhibit 7.1B. A separate Exhibit 7.1B should be included for the first phase of the Project as well as one for the complete Project and separate Exhibits for each scenario. There is more ambiguity with regard to the definition of some O&M costs than with capital costs, so the PROPOSER is encouraged to provide an explanation of assumptions used in preparing the Exhibits 7.1B and to detail the operating plans summarized on the Exhibits. In all cases, fixed and variable costs should be clearly identified.

7.1.6 PROPOSED PRICE FOR POWER

The PROPOSER should complete an Exhibit 7.1C for the first phase of the Project as well as an Exhibit 7.1C for the complete Project. Again, the PROPOSER should complete a separate Exhibit 7.1C for the base case and for each alternative scenario evaluated. Exhibit 7.1C should be supported by Exhibits 7.1A and B so that the numbers on Exhibit 7.1C can be reproduced. The PROPOSER is strongly urged to also supply a qualitative/quantitative analysis detailing the PROPOSER'S perception of the financial and economic feasibility of the project. Exhibit 7.3A is provided for this purpose but is unstructured as HECO does not want to force a PROPOSER into what may be an inappropriate mold to best present the PROPOSER'S case.

7.1.7 OPERATIONAL CONSTRAINTS AND EFFECTS ON REVENUE

There may be situations where the PROPOSER is concerned that some present or future action on the part of HECO, the State of Hawaii or some other party may adversely affect the operation of the Project and thus the revenue stream. The PROPOSER is encouraged to highlight these concerns on Exhibit 7.1E so that they may be discussed with PROPOSER during the evaluation phase.

7.2 CONTRACTUAL PROVISIONS

7.2.1 POWER PURCHASE AGREEMENT

This subsection describes the general terms and conditions that HECO expects to be included in a PPA (or related documents, if appropriate) entered into between HECO and a successful PROPOSER. HECO intends to negotiate contracts with no more than two PROPOSERS before a final selection is made and a contract(s) is executed.

The PPA will establish the contractual rights and obligations of the parties pursuant to which the DEVELOPER will deliver and HECO will purchase electric energy and capacity from the Project. In general this means, but is not limited to, the establishment of terms and conditions that will assure HECO of reliable power with a high availability factor from a geothermal powerplant or powerplants located on the island of Hawaii and delivered to and purchased by HECO at a designated point of interconnection on the island of Oahu. It is anticipated that such energy and capacity will be made available by an agreed upon time and for an agreed upon term. It is also HECO's expectation that the purchase price to be paid by HECO for power under the PPA will not exceed HECO's avoided cost at the time of power delivery. In addition, HECO will wish to specify in the PPA (or related documents): (1) the circumstances (including limitations) when such capacity and/or energy would be provided or curtailed; (2) those guarantees, warranties and security arrangements required by HECO of the DEVELOPER (and such other parties that might serve as guarantors to the obligations of the DEVELOPER) that will operate to ensure performance of the DEVELOPER'S obligations to supply power to HECO; and (3) insurance coverage, damages provisions, indemnification rights, and other negotiated provisions including HECO's right to operate the Project under certain circumstances, designed to provide a remedy to HECO for the DEVELOPERS non-performance according to the PPA.

7.2.2 GENERAL DESCRIPTION OF TERMS AND CONDITIONS TO POWER PURCHASE AGREEMENT

The selected PROPOSER(S) and HECO will attempt to negotiate a PPA that includes, but may not be limited to, the following general provisions (the specific language of such provisions will be the subject of negotiations):

- Term of agreement - 30 years - with right of the parties to negotiate a longer term or the extension of a completed term, the right of HECO to defer or cancel delivery of energy or capacity from the Project and rights of HECO to purchase the Project or components of the Project upon expiration of the term or extended term;

- Price for delivered energy during startup and testing and then for delivered energy and available capacity at the date of in-service operation of the Project to be negotiated between the parties to the PPA;

- Milestone schedule of tasks to be performed by the DEVELOPER with such schedule to be made a part of the PPA; failure to meet any milestone may be considered an event of default and could result in termination of the contract or such other remedy as provided by the terms of the PPA;

- Guarantees, warranties and security agreements that are intended to insure the performance of obligations undertaken by the DEVELOPER;

- Specified liquidated damages if the Project does not meet agreed upon milestone dates, performance standards or other conditions or circumstances recognized and agreed upon by the parties to the PPA;

- Rights of HECO to evaluate construction plans and specifications, schedules, testing data, operation data and performance data of the Project; to operate the Project or any components of the Project if certain prescribed circumstances exist; and to curtail acceptance of electricity in the event of system emergency or other specified conditions;

- Events of default and remedies for events of default, including termination of the PPA as well as agreed upon rights and remedies and such other remedies as afforded the parties by operation of law and in equity;

- Interconnection to HECO's transmission system with costs to interconnect to be borne by the DEVELOPER; provisions for metering, telemetering, testing and special arrangements to safely interconnect into the HECO transmission system; and

- Insurance that provides normally accepted coverage limits for projects of the magnitude contemplated; geothermal reservoir insurance coverage or other agreed upon forms of protection for failure or inadequate production of the geothermal resources to be utilized; and such other indemnification provisions as may be agreed upon by the parties to the PPA.

7.2.3 DESCRIPTION OF THE REQUIRED GUARANTEE STRUCTURE FOR THE PROJECT

The capacity and energy produced and delivered by the Project is needed to meet the anticipated requirements of HECO's customers. To best ensure that the electric power from the Project will be delivered at the time and in the manner prescribed in this RFP, and to provide evidence and assurances of a PROPOSER'S ability to perform as outlined herein, HECO seeks to obtain reasonable and adequate performance guarantees from the PROPOSER. HECO's expectations concerning the substantive requirements of these guarantees are set forth in this section. These guarantees will be set forth in the PPA, or may be set forth in other documents as the parties deem appropriate. Other specific terms expected to be included in the PPA are also set forth in other sections of this RFP.

In evaluating any Proposal, HECO will consider the adequacy of performance guarantees of the PROPOSER, or of other parties in support of the PROPOSER of the proposed Project. Those performance guarantees should act to mitigate HECO's risks, which relate to HECO's obligations to provide adequate, safe and reliable electric service to its customers while maintaining the operational stability of its system.

In addition, HECO will evaluate the adequacy of guarantees in the form of damages for non-performance. The damages which HECO would sustain as a result of the proposed Project's non-performance and failure to meet these guarantees are difficult to measure by easily predictable standards. Therefore, HECO anticipates that its remedies for the non-performance of the DEVELOPER will include liquidated damages based upon HECO's best estimates of damages it might sustain in the event of failure to meet certain guarantees.

This section of the RFP is intended to provide the PROPOSER with information as to the type, manner and degree of guarantees required of the PROPOSER and the extent of obligations of the PROPOSER and related parties which HECO believes are necessary in order for HECO to confidently pursue the purchase of energy and capacity from the Project. The descriptions provided in this section are descriptive and informational only and are not intended to be a complete listing of all those provisions which may be a part of the PPA or of other Project documents to be negotiated with HECO. In addition, HECO reserves the right to include in the PPA negotiations revisions or changes to the provisions described in this section, based upon HECO's evaluation of the Proposals.

7.2.3.1 Milestone Schedule

A milestone schedule of tasks to be performed by the DEVELOPER should be provided in the Proposal to be finalized and included in a PPA (see Section 5.3). The schedule must address the following: licensing and permitting approvals; site acquisitions; architect and engineering selections; detailed facility design; equipment procurement through the bid, selection and award processes; delivery and installation of critical components and equipment; arrangements for both short-term construction financing and permanent financing; interconnection and transmission agreement(s) (if applicable); geothermal resource acquisition; geothermal resource verification; and testing, start-up and in-service dates of the geothermal powerplant(s), transmission system and electricity converter stations.

The proposed schedule, after negotiation, will be included in the PPA. Failure to meet the milestone schedule contained in the PPA, unless otherwise agreed to, will be considered an event of default. Depending upon the final milestone schedule agreed upon by HECO and the DEVELOPER, such event of default may result in termination of the PPA, liquidated damages, takeover and completion and/or operation of the Project by HECO or its assignees, or such other remedies as may be available at law or in equity.

7.2.3.2 Right of HECO to Defer or Cancel

HECO will seek to include provisions in the PPA which would allow HECO to defer the Project's in-service date, or to cancel the Project or portions thereof, if HECO determines that the capacity additions to be provided by the Project should be deferred or canceled because projected load growth or the need to replace existing capacity in Oahu has changed materially from current projections, or because other currently unforeseen events occur which necessitate HECO taking such action. HECO and the DEVELOPER will mutually agree upon the terms and conditions for such postponement or cancellation as well as any fees, penalties or similar charges to be paid in the event HECO must exercise such right of deferral or cancellation.

7.2.3.3 Security Interests

HECO will seek a subordinated security interest in any escrow or reserve accounts established in connection with financing for the Project. Such security interests will serve to secure, in part, the DEVELOPER'S obligations to HECO pursuant to the PPA.

7.2.3.4 Equipment Guarantees

Equipment, process or system guarantees are to be provided by the individual suppliers. The right to enforce such guarantees should be assignable to HECO in the event HECO shall exercise rights to complete or operate the Project or any portions thereof.

7.2.3.5 Guarantor Commitments

To insure completion of the Project, HECO may also seek the following from the DEVELOPER:

Depending upon the proposed business structure of the DEVELOPER, it may be necessary to seek a guarantee of performance from a third party or parent organization of a DEVELOPER or party related thereto. Such a party should have resources sufficient to provide a guarantee for an agreed upon monetary amount which is related to a level of completion of the Project.

In the alternative, the DEVELOPER would be required to provide an unconditional irrevocable direct pay or standby letter of credit, or bond issued by a bank acceptable to HECO, in form and substance acceptable to HECO.

7.2.3.6 Loss or Reduction of Service

This RFP specifies that the PROPOSER should describe the expected time for delivery of power and the level of performance and reliability required of the proposed Project in order to meet the needs of HECO (see the description in Chapter 5). With respect to those specifications, the PROPOSER should consider the following:

Reduced (less than stated) availability of capacity from the Project would cause severe operational impacts on HECO's system which may result in economic and load constraints that are unplanned and unacceptable to HECO. The expected availability from this Project is set forth in Section 5.1. Proposals should contain guarantees by the PROPOSER that the Project's design and equipment will perform as stated. In the event that such performance is not attained on average in each and any contract year or portion thereof, the DEVELOPER will be required to pay to HECO in liquidated damages an agreed upon sum for each one-tenth (1/10) of a percentage point that the availability of the Project falls below the level guaranteed by the DEVELOPER.

When accepting relatively large amounts of capacity as proposed for this Project, HECO must be able to depend on regular delivery of such capacity. Unplanned reductions (less than stated) of capacity or reductions with insufficient notice to HECO will result in economic and operational hardships that are unacceptable to HECO and its customers.

The DEVELOPER must warrant and guarantee that the Project, and all associated components thereof, will have and maintain the ability to continuously produce and deliver an agreed upon capacity (plus or minus one percent) to the metering point for the contract period. The contract period will commence after a specifically stated period for testing and start-up, with agreed capacity to be as requested by HECO's dispatchers, between 0.98 leading and 0.85 lagging power factor at the metering point.

The DEVELOPER will be required to pay specified liquidated damages to HECO for any reduction in capacity from the agreed upon amount until the deliverable capacity can be raised to the contractually required levels.

Scheduled maintenance of the Project, and all components thereof, should be coordinated with HECO. Prior to July of each year, the DEVELOPER will be required to submit for review and comment by HECO an initial schedule of expected energy delivery periods for the sixty (60) month period beginning with January of the following year. The schedule shall state the estimated periods of operation, number of anticipated and scheduled shutdowns or reductions of output and the reasons therefor, and the proposed dates and durations of scheduled maintenance requiring shutdown or reduction in output of the Project. HECO will seek compensation related to HECO's cost of replacement power in the event any scheduled outage exceeds the time planned for such outage.

Where it is determined that a condition exists at the Project which will have a materially adverse physical impact on HECO's electric system or the equipment of HECO's customers and which requires, in HECO's sole judgement, a change in electricity deliveries by the Project, the DEVELOPER will be required to suspend or reduce deliveries and, if immediate danger to personnel or electrical system equipment exists, HECO will be able to remotely separate the Project from the HECO system. Where the operation of the Project is causing or contributing to the adverse condition, the DEVELOPER, at its own cost, shall be required to modify its electric equipment or operations to the extent necessary to promptly resume full deliveries of electricity to HECO.

If the Project trips off-line in excess of an agreed upon number of times each year, the DEVELOPER shall be assessed agreed upon liquidated damages.

7.2.3.7 Right to Purchase Project (or any Components thereof) or to Extend Term of the PPA

In order to ensure continuity of deliveries of the capacity and energy of the Project for the benefit of HECO's customers, HECO shall seek to establish rights in the PPA to purchase the Project or any components of the Project (including the transmission system and/or the geothermal powerplant(s)) and/or to extend the term of the PPA. This RFP is not to be interpreted as a solicitation on the part of HECO of an ownership interest in the Project.

Should the DEVELOPER desire to dispose of its right, title or interest in the Project, in whole or in part, other than through the sale and leaseback of the Project or other assignment or disposition for purposes of financing the Project, or any component or part thereof, HECO shall retain a first right to purchase the Project, or any component thereof, from the DEVELOPER.

At an agreed upon time during the term of the PPA, HECO shall have the right to seek an extension of the term of the agreement.

7.2.4 DESCRIPTION OF INSURANCE REQUIREMENTS

The DEVELOPER shall, at its own expense, acquire and maintain, or cause to be maintained, for the mutual benefit of HECO and the DEVELOPER the insurance herein specified and such other insurance as may be deemed appropriate in the circumstances and shall furnish to HECO Certificates of Insurance evidencing such insurance as of the effective dates established in the PPA and throughout the term of the contract. The DEVELOPER shall also provide evidence of insurance, as applicable, upon each annual renewal. Such certificate shall provide for 60 days prior written notice to HECO of any policy cancellation or modification. The DEVELOPER shall agree to notify HECO of any material changes in or cancellation of any policy prior to the effective date of such change or cancellation. The adequacy of the coverage afforded by the required insurance shall be commensurate with the size of the Project, and shall be subject to mutual review by HECO and the DEVELOPER from time to time, and, if prudent and in keeping with electric utility industry standards, the DEVELOPER shall forthwith increase such coverages and/or limits to the extent required, the costs of such increased coverages and/or limits to be borne by the DEVELOPER. HECO shall be named an additional insured under the policies described below to the extent applicable.

If the PROPOSER believes that any of the insurances described in the following sections are not commercially available or available only with an extremely high premium, the PROPOSER should so state in the Proposal and supply the necessary documentation to support the PROPOSER'S position.

7.2.4.1 Worker's Compensation and Employer's Liability

This coverage shall include worker's compensation, temporary disability and other similar insurance required by applicable Hawaii state or federal laws. If exposure exists, coverage required by the Longshore and Harbor Worker's Compensation Act (33 U.S.C. 901-952) and the Jones Act (46 U.S.C. 688) should be included. Additionally, coverage should include a voluntary compensation and employer's liability endorsement for employees not subject to the worker's compensation laws. The agreement will establish employers' liability coverage limits for bodily injury by accident and bodily injury by disease.

7.2.4.2 General Liability Insurance

This coverage should include either comprehensive general liability or commercial general liability insurance covering all operations by or on behalf of the DEVELOPER. Such coverage should provide insurance for bodily injury and property damage liability and should include coverage for:

- Premises, operations, and mobile equipment,
- Products and completed operations,
- Owners' and contractors' protective liability,
- Contractual liability insuring the obligations assumed by the DEVELOPER resulting from the PPA,
- Broad form property damage (including completed operations),
- Explosion, collapse, and underground hazard, and
- Personal injury liability.

7.2.4.3 Automobile Liability Insurance

This insurance should include coverage for owned, leased and non-owned vehicles. Coverage should include liability for bodily injury and property damage. If general liability insurance is provided by a commercial general liability policy, then the automobile liability insurance policy required herein should include coverage for automobile contractual liability.

7.2.4.4 Builders All-Risk Insurance

As a minimum, HECO will require evidence of insurance for earthquake, flood, tsunami, volcanic eruption or other natural disaster perils, including coverage during transit, testing, incidental storage, and delay costs, and coverage for structures, equipment, buildings, improvements and temporary structures used in construction, or as part of the permanent Project from the start of construction through the in-service date. The coverage should be no less than the full amount of replacement value of property items covered (unless a lower value is agreed to by HECO), subject to a reasonable deductible. In the event that it is not possible to obtain coverage for all of the perils noted herein, or the PROPOSER concludes that another means of protection is more practicable, then the PROPOSER should describe the means by which the protection sought by such insurance coverage might otherwise be obtained. One purpose of this requirement is to provide assurances to HECO that, if a natural disaster occurs before or during construction, the DEVELOPER will have the financial resources to complete the Project.

7.2.4.5 <u>All-Risk Property/Comprehensive Boiler and Machinery Insurance (Upon Completion of Construction)</u>

This insurance should provide all-risk property coverage (including the perils of earthquake, flood, tsunami, volcanic eruption, or other natural disaster) and comprehensive boiler and machinery coverage against damage to the Project, or any components thereof, in amounts not less than the full replacement cost of the Project (unless a lower value is authorized by HECO) to restore the Project to its condition prior to the casualty loss and subject to a reasonable deductible. Such policies should be endorsed to require that:

a. Complete copies of each inspection or other report required by or performed for the insurer shall be provided to HECO.

b. The coverage afforded shall not be canceled or reduced without prior written notice to HECO.

In the event that such insurance cannot be obtained for volcanic eruption, for example, then the PROPOSER should propose some other alternative method by which the full replacement cost of the Project, or any component thereof which is the subject of the casualty loss, will be guaranteed and assured.

7.2.4.6 Business Interruption Insurance (Upon Completion of Construction)

This insurance should provide coverage for all of the DEVELOPER'S costs to the extent that they would not be eliminated or reduced by the failure of the Project to operate (including, but not limited to, rent or mortgage payments, geothermal resource lease payments, interest and principal payments on loans or bonds, and salaries and wages) for a period of at least twelve (12) months after a reasonable deductible period or reasonable dollar deductible.

7.2.4.7 Geothermal Reservoir Insurance

The PROPOSER should propose geothermal reservoir insurance coverage or such other form of coverage as agreed to by HECO for loss of the geothermal resources that are necessary to maintain and operate the geothermal powerplant(s) of the Project. Such insurance should be available to cover the DEVELOPER'S costs of drilling new wells, re-drilling existing wells or taking such actions which the DEVELOPER and HECO believe are necessary to insure that sufficient geothermal resources exist at temperatures and pressures required to operate the Project at the net electrical output levels required by the PPA.

It is recognized that geothermal reservoir insurance may not be obtainable for this Project. If not available, then the PROPOSER should propose, and fully describe, such alternative mechanism by which HECO might be assured that the DEVELOPER will be financially capable of drilling additional wells or taking such other actions as may be necessary to maintain sufficient geothermal resources, at the requisite temperatures and pressures, necessary to operate the Project at agreed upon levels and durations.

7.2.4.8 Project Liability Errors and Omissions Insurance or Agreed Upon Alternatives

The PROPOSER should be adequately protected against project liability errors and omissions on account of actions or inactions of architects, engineers, contractors and subcontractors involved in the design and construction of the Project. Evidence of this protection may be provided through any one or more of the following mechanisms: (i) construction contract(s) with the above parties who have sufficient financial creditworthiness to cover project liability errors and omissions; (ii) loan agreement(s) with the above parties; or (iii) reserve account(s) which may be used to correct material deficiencies associated with the Project; provided, however, that if HECO reasonably determines that the above mechanisms would not provide protection similar to that which would be provided through project liability errors and omissions insurance for the Project with suitable liability limits of insurance for a five (5) year period after the in-service date, DEVELOPER will maintain or be required to maintain such Project liability errors and omissions insurance.

7.2.5 REQUIREMENTS FOR INDEMNIFICATION

Requirements for indemnification by the DEVELOPER shall be included in the PROPOSER'S Proposal.

7.2.6 DESCRIPTION OF EVENTS OF DEFAULT AND REMEDIES AVAILABLE DUE TO DEFAULT

7.2.6.1 Events of Default

The PPA shall specify events that at any time during the operation of the PPA shall constitute an "event of default". Subject to further negotiation, the following events shall constitute event(s) of default:

- Failure to achieve any milestone requirement, unless such milestone is waived in writing by HECO.

- Failure of the Project to achieve an in-service date of any increment where the cause of such failure is not the occurrence of force majeure.

- Failure of the DEVELOPER to pay HECO any amount as and when due under the PPA, if such delinquency is not remedied within a specified grace period after demand, in writing, has been tendered by HECO.

- Failure of the DEVELOPER to use reasonable diligence in operating, maintaining, or repairing the Project, or any component thereof, such that the safety of persons and property, HECO's equipment, or HECO's service to its customers, is adversely affected, and/or failure to use reasonable diligence within a specified time after notice and demand by HECO for correction of this failure.

- Abandonment of the site or the discontinuance of design, construction, startup, testing or power production, plant operation or transmission of electricity for a period of three (3) or more consecutive days, the last twenty-four (24) hours of which shall be after notice to DEVELOPER that it is not in compliance with the PPA.

- Failure of the DEVELOPER to meet the performance requirements specified in the PPA beyond those covered by liquidated damages.

- The taking of any action under any state or federal bankruptcy or insolvency laws by or against the

DEVELOPER, any consortium of which DEVELOPER is a member, or any guarantor of the Project.

- The DEVELOPER becomes insolvent or unable to pay debts as they become due; the holder or holders of any obligations for money borrowed by the DEVELOPER accelerates the repayment thereof; DEVELOPER does not discharge an obligation for the payment of sums of money above an agreed upon amount that has been ordered pursuant to a final court order, judgement or decree entered in any proceeding against the DEVELOPER or DEVELOPER fails to make any payment and subsequently becomes delinquent for materials or labor used in the engineering, design, construction, maintenance or operation of the Project; DEVELOPER defaults on any obligation to a third party which results in an acceleration of remedies available to that third party which could result in a transfer either physically or legally of, or a lien on, the Project, its assets or its facilities.

- Without the approval of HECO, the DEVELOPER transfers, conveys, loses or relinquishes its right to own or operate the Project or to occupy the site where the various components of the Project are located.

- Failure by the DEVELOPER to make all reasonable efforts to restore the Project to full or substantially full operating condition following any casualty loss.

- The security provided by or for the DEVELOPER and made a part of the PPA becomes, or is reasonably likely to be, substantially impaired.

- An event of default by the DEVELOPER under any of the financing documents utilized in conjunction with the financing of the Project occurs and HECO determines in good faith that its rights under the PPA are likely to be impaired as a result of the parties to the financing of the Project exercising their remedies.

- The DEVELOPER fails to maintain in full force and effect throughout the term of the PPA either the securities specified in the PPA or the issuer of the securities fails to pay to HECO any amount as and when due under such securities.

- The DEVELOPER becomes involved in a labor dispute after the in-service date which results in a shutdown or reduction in output of the Project of more than 125 MW for more than seventy-two (72) hours.

- The DEVELOPER fails to perform a material obligation of the PPA not otherwise specifically referred to in this section and such failure continues for a specified period of time after written demand by HECO for performance thereof.

7.2.6.2 Remedies Available Upon Default

Upon the occurrence of an event of default by the DEVELOPER, HECO may, at its option, seek payment of damages from the DEVELOPER (liquidated damages to be established for some events of default), terminate the PPA and take over operation of the Project and/or institute such legal action or proceedings or resort to such other remedies as it deems necessary.

HECO, at its option, shall have the right to assume all of the DEVELOPER'S interests, rights and obligations in the Project to the extent it is legally capable of doing so, to take over the construction or operation of the Project and construct or operate the Project during the period in which the foregoing assumption of DEVELOPER'S interests, rights and obligations is being perfected and to complete the construction of and/or operate the Project.

HECO may exercise, at its election, any rights and claims and obtain any remedies it may have at law or in equity, including, but not limited to, compensation for monetary damages, injunctive relief and specific performance. The DEVELOPER will acknowledge and agree that a failure to perform any of its obligations under the PPA (other than obligations to make payments to HECO) would cause irreparable injury to HECO and that the remedy at law for any such failure or threatened failure would be inadequate. Accordingly, the DEVELOPER will agree that HECO need not prove the inadequacy of legal remedies in order to become entitled to a temporary or permanent injunction or other equitable relief specifically to enforce any such obligation.

7.3 INFORMATION ON PROPOSER

In evaluating Proposals submitted under this RFP, HECO will require reasonable assurances that the PROPOSER has the financial and management capability to develop and operate the Project in a timely, financially sound and effective manner, consistent with the other requirements of this RFP. HECO will not accept a Proposal unless the Proposal demonstrates that the Project is financially feasible and that the proposed management structure is adequate to permit HECO to rely upon the expectation of successful Project development to help meet its capacity planning requirements. To assist HECO in this assessment, the Proposal must include: a full description of the identity, composition and financial condition of the PROPOSER, a financing plan and a detailed plan for management of Project development and operation.

7.3.1 PROPOSERS LEGAL IDENTITY AND COMPOSITION

Each Proposal must identify an entity currently in existence or which will be in existence prior to contract negotiations who will be responsible for the Project (the PROPOSER). The Proposal shall contain a full description of the business activities, financial circumstances and management structure of such PROPOSER as described in the following sections.

If the entity is not in existence at the time the Proposal is submitted, the Proposal must identify who will act for the entity in responding to questions during the Proposal evaluation phase.

If the PROPOSER is a corporation, it must be a U.S. corporation and the state of incorporation must be identified. All corporate owners of this corporation must also be identified.

If the PROPOSER is a joint venture, the Proposal must identify all participants and their percentage participation. Furthermore, each Proposal shall identify those organizations or parties responsible for proposing and accomplishing all phases of the proposed Project (the Project team).

The Project team includes the legal entity responsible for the Project (i.e., the PROPOSER), the subcontractors, technology licensors, and host-site offerers that are identified in the Proposal. The Project team also includes those guarantors of Project completion, lenders of funds to conduct the Project, and, if appropriate, insurers of the Project. Where a legal entity has been or will be created to conduct the Project, the participating organizations or parties (partners, joint venture members, etc.) are also considered to be Project team members.

To document the Project team agreement(s), each member of the team should provide to HECO a legally binding agreement, or letter of intent to reach such agreement, with the prospective participant that clearly and explicitly states its respective role in the Project and the nature of its relevant business relationship for purposes of this Project. These documents should be signed by a corporate official or other appropriate person authorized to legally bind the aforementioned entities. These letters should be included in the Commercial Proposal.

7.3.2 FINANCIAL REQUIREMENTS

7.3.2.1 Existing Entity

If the PROPOSER is an existing entity not formed specifically to undertake this Project and is otherwise engaged in other business activity, the PROPOSER must provide:

- current financial statements for all business quarters reported on in the current fiscal year (or the immediately preceding fiscal year, if no quarterly statements have been reported);
- an audited financial statement for the prior three fiscal years; and
- a comprehensive description of the business activities of the PROPOSER during the preceding five fiscal years; and
- the most recent SEC form 10K that is available.

The PROPOSER may also provide such additional information as the PROPOSER considers useful to HECO in evaluating the financial ability of the PROPOSER to undertake the Project.

7.3.2.2 <u>New Entity</u>

If the legal entity (i.e. PROPOSER) came into existence, was incorporated or was otherwise formed specifically to conduct this Project, or will be formed prior to the selection of a Proposal by HECO, the PROPOSER must provide:

- a complete, current list of all investors in the PROPOSER;
- such financial statements as may be available for the PROPOSER;
- audited financial statements as described in Section 7.3.2.1 for each investor in the PROPOSER;
- audited financial statements as described in Section 7.3.2.1, for any predecessor organizations to the PROPOSER and for any organization with previous investment interest in the PROPOSER;
- audited financial statements as described in Section 7.3.2.1 for any entity identified in the Project financial plan or elsewhere in the Proposal as a guarantor or possible guarantor of the Project;
- a description of the business relationships among the investors in the Project;
- a copy of any agreements (or adequate summaries of any agreements) establishing relationships among the PROPOSER and investors and among the investors, including joint venture and partnership agreements, service supply agreements and similar matters; and

- the most recent SEC form 10K available for each investor. If the investor is a non-U.S. entity, provide equivalent information.

7.3.3 <u>FINANCING PLAN</u>

The Proposal shall include a financing plan for the Project which shall identify the amount and proposed source of funds needed to complete development of the Project and shall describe the material terms and conditions under which the financing for the Project would be obtained.

The financing plan shall describe the total projected financing and financing costs for the Project, including a description of material financial and economic assumptions such as interest and discount rates. This description shall be specific, and shall include a timetable indicating the amount of funding that must be available in each Project year, and the plan for debt service and return on equity for the duration of Project operation.

The financing plan shall also be accompanied by an analysis of the economic assumptions underlying such plan, sufficient to permit HECO to conclude that the Project will be financially feasible if developed pursuant to such financing plan.

The financing plan shall describe the proposed source of funds, including the proposed allocation of debt and equity funding.

a) With respect to equity funding, the financing plan shall to the fullest extent practicable:

    - describe the extent of DEVELOPER contribution to equity funds, and the source of such funds;

- describe the extent to which (and terms upon which) other equity participants will be sought or have been committed;

- identify other possible sources of equity participation, and the reliability of such other sources;

- identify any proposed broker and the form of equity solicitation;

- provide all available evidence of the reliability of other equity participants, including executed agreements, certification of private financing, firm letters of intent, or similar documentation or adequate summaries of such evidence;

- identify other outstanding obligations of the PROPOSER and other equity participants, including liabilities, limitations, conditions and other factors that affect or may affect the availability of the PROPOSER'S funds for the Project;

- identify plans for supplemental equity financing;

- identify any special priorities or restrictions on dividends or other forms of return of equity investment necessary to secure debt financing;

- indicate whether the DEVELOPER or any other Project participant will finance any portion of the equity contribution on a recourse basis;

- identify any special terms and conditions, unique to a Project of this size and character, which the

PROPOSER believes must be offered to equity participants to permit financing of the Project under the terms of the financing plan. If the PROPOSER concludes that no such special terms and conditions exist, it should state the basis for such conclusion.

b) With respect to debt financing, the financing plan shall to the fullest extent practicable:

- identify the amount and character of debt financing for the Project;

- describe the expected sources of such funds and the basis for believing such funds will be available;

- provide evidence documenting the availability of debt financing including letters of intent, contractual agreements, certification of private financing, or similar documentation or summaries of such evidence;

- describe, to the extent possible, the types of instruments expected to be used, and the essential terms and priorities governing repayment;

- describe the amount and character of security, including any collateral and guarantees;

- describe the types and estimated fair market value of assets (if any) that will be pledged as collateral for any outside financing;

- indicate whether, and the extent to which, the DEVELOPER will seek state and local grants, loans or other funding or financial assistance (including tax forgiveness or postponement), the source of such funds or financial assistance, and the importance of the availability of such assistance to the financial feasibility of the Project;

- describe guarantees or remedies upon default that will be included in loan agreements;

- describe any guarantees of affiliated or other persons that the PROPOSER or other participants expect to obtain;

- describe what, if any, changes in ownership and financing structure or operation of the Project are expected to occur upon completion of the development phase of the Project; and

- identify any special terms and conditions that will be required to provide sufficient debt financing for the Project. If it is assumed that no special terms and conditions are required, the basis for that assumption should be described.

c) The financing plan should also include:

- a schedule of Project funding requirements (combined debt and equity);

- identification of any likely variable terms that could alter cash flow projections;

- the expected price for energy and capacity provided by the Project; and

- sensitivity analyses indicating the effect of reasonable Project delays on cash flow requirements and overall financing costs.

HECO is aware that some of the information described above will not be fully developed at the time of submission of a Proposal. However, the PROPOSER should recognize that the assessment of the Project's financial feasibility is critical to the overall viability of the Project. Therefore, the thoroughness and adequacy of the PROPOSER'S financing plan will be a material consideration in HECO's comparative evaluation of Proposals submitted in response to this RFP.

7.3.4 MANAGEMENT STRUCTURE

The Proposal shall include, to the fullest extent practicable, a complete description of the management responsibilities that will be borne directly by the DEVELOPER. It shall identify other persons, in addition to the DEVELOPER, who will be responsible for any phase of Project development (i.e. members of a Project team including proposed contract management, if any); a description of the allocation of responsibility for management of Project development; and a general management plan.

Legally binding agreements or letters of intent to reach such agreements with the DEVELOPER and key members of the Project team should be provided. In addition, the Proposal should identify, to the fullest extent practicable, any other team members expected to be added, and describe the timetable and method for obtaining a binding commitment.

The Proposal should identify all major subcontractors, technology licensors, host-site offerors, and geothermal resource owners who will participate in the Project.

The Proposal should include a management plan for both Project development and operation. This management plan should, as fully as possible, provide:

- a description of the allocation of responsibility among members of the Project team, including organizational charts depicting organizational and functional relationships of key personnel within the corporate and/or Project team structure;

- an organizational chart showing key personnel, with man-hours and percentage of key personnel time that will be devoted to the proposed Project;

- resumes of key personnel, describing education, technical/management experience, and professional qualifications;

- a description of key personnel's experience and success with projects involving similar or related technologies, and projects of similar scope or complexity; and

- a description of the allocation of responsibility for operation of the transmission lines and associated facilities, and a plan for operation of such lines and facilities, including a description of any cooperative relationship with HECO, if necessary, for ensuring reliable operation of the facility.

The PROPOSER may also provide such additional information as the PROPOSER considers useful in evaluating the management capability of the PROPOSER to undertake the Project.

7.3.5 PRIOR EXPERIENCE

In those sections of the RFP that describe and discuss the PPA and the management and financial structure of the PROPOSER, there are a set of explicit questions and requests for detailed information which will assist HECO in determining the qualifications of the PROPOSER, and related parties, to undertake the Project sought by this RFP. The PROPOSER is encouraged to respond in full to the information sought by those sections of the RFP. The additional questions set forth here are intended to provide HECO with further information about the prior experience of the PROPOSER, or related parties, in the development, construction or operation of similar energy projects, including, most importantly, projects involving geothermal resources or projects owned or operated by a non-regulated entity selling electricity to a regulated utility. To the extent that the PROPOSER has fully and directly addressed these questions in other portions of the RFP, a cross-reference may be appropriate.

- What experience has the PROPOSER, or a related party, had in developing a project of the size and complexity proposed? Please be specific in describing the type of project, whether the PROPOSER, or related party, was a DEVELOPER or contractor, and whether the PROPOSER, or related party, participated in financing the project or negotiating the power purchase agreement, if any.

- Has the PROPOSER, or a related party, owned (including current ownership), operated, or participated as a contractor in the construction of a project which utilizes geothermal resources. Please describe the project, the role of the PROPOSER or related parties and location of the project.

Please provide a list of persons to contact who might discuss the qualifications and performance of the PROPOSER or related party with respect to the projects described above.

7.3.6 REGULATORY ISSUES

The PROPOSER should identify the regulatory requirements, if any, that may affect the financing or management structure of the Project. Specifically, the Proposal should indicate whether or not federal law, including the Public Utility Holding Company Act and the Public Utilities Regulatory Policy Act, or Hawaii state law including Chapter 269, Hawaii Revised Statues and the PUC's rules may or will affect the financing or management structure, and how the proposed ownership and management structure is adequate to address such issues. The PROPOSER should also identify any other regulatory requirements, including permitting of the Project, that may affect timely development and discuss how the proposed management and organization structure will address such issues, if any.

7.4 EVALUATION CRITERIA

The following business, management and financial evaluation criteria will be applied to evaluate the Commercial Proposal volume to be submitted by the PROPOSER in response to this RFP:

7.4.1 FINANCIAL CONDITION, CAPABILITY TO FINANCE AND FINANCING PLAN

In assessing a PROPOSER'S financial capability and financing plan HECO will:

- examine the adequacy and completeness of the plan to finance the project;

- assess the financial condition and capability of the proposed funding sources to provide the equity and debt funding for the project; and,

- determine the ability of the PROPOSER to initiate and successfully conclude the financing for the Project, (including meeting milestone schedules) as evidenced by prior experience(s) of the PROPOSER or related parties in the financing of projects of similar magnitude and complexity.

In analyzing the PROPOSER'S financing plan, HECO will also examine the PROPOSER'S projections of the economic viability of the proposed Project. To conduct this evaluation, HECO will:

- analyze the PROPOSER'S projections of cash generated from the Project to determine if sufficient cash is available to cover all costs of operation and debt service and to provide an adequate overall incentive to sponsors; and,

- examine all receipt and disbursement items and other factors which could affect cash flow.

HECO will not dictate economic assumptions such as interest rates to be used by the PROPOSER in responding to this RFP. However, in its comparative analyses of competing Proposals, HECO will make adjustments in economic assumptions needed to ensure evaluation of Proposals on a common basis. In addition, HECO may test the reasonableness of the PROPOSER'S economic assumptions against HECO's business assumptions and, if appropriate, the views of independent analysts consulted by HECO for this purpose. The PROPOSER, therefore, should provide the assumptions, data, and algorithms used in constructing financial statements (examples: inflation rates, interest rates, depreciation schedules, utilization rates and product prices) in sufficient detail to allow HECO to replicate the financial pro formas submitted. (See

Exhibits 7.1A, B and C) It will facilitate HECO's review if the foregoing is provided on hard copy and in IBM-PC Lotus 1-2-3 magnetic diskette form.

7.4.2 ORGANIZATIONAL CREDENTIALS, AVAILABILITY AND QUALITY OF PROJECT PERSONNEL RESOURCES AS EVIDENCED IN THE MANAGEMENT PLAN

In assessing a PROPOSER'S management capabilities, HECO will examine the experience and expertise of:

- the PROPOSER and related parties in the development and conduct of projects comparable to this Project;
- key individuals in the project management;
- as identified by the PROPOSER, appropriate members of the project team.

The management plan will be reviewed in terms of the following factors:

- the experience of individuals with projects of similar size and complexity who are designated as project managers and as key project engineers with projects of similar size and complexity;

- the quality and composition of the PROPOSER'S technical team responsible for reviewing the design work of the contractors and process licensors and for assessing and controlling reliability, usages and risks;

- the provisions made for cost, progress and procurement monitoring and control during construction; and

- the PROPOSER'S operating plans and previous experience to manage both the technical and administrative aspects of the proposed Project.

- the availablilty of individuals and groups who are part of the project team, how they will operate and how they will be supervised.

7.4.3 PERFORMANCE GUARANTEES, INSURANCE AND INDEMNIFICATION REQUIREMENTS

In assessing the ability of the PROPOSER to successfully undertake and complete the Project HECO will evaluate;

- the degree to which the PROPOSER will provide, or is capable of providing, those performance guarantees more fully explained in section 7.2;

- the type, amounts and quality of insurance coverage required of a project of this size and complexity;

- the expressed willingness of the PROPOSER to assume those risks and responsibilities that are set forth in the RFP and which HECO intends, through negotiation, to make a part of the PPA or related agreements.

7.5 REFERENCES FOR CHAPTER 7

1. National Association of Regulatory Utility Commissioners. Uniform System of Accounts for Class A and B Electric Utilities. 1976.

Reference 1 may be obtained from the National Association of Regulatory Utility Commissioners. 1102 Interstate Commerce Commission Building. P.O. Box 684. Washington, D.C. 20044-0684. Telephone 202-898-2200. A copy is also in the public document room.

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-0001

ATTACHMENT 7.1A

November 25, 1988

George T. Iwahiro
Vice President
Consumer, Regulatory
& Public Affairs

FILED
Nov 25 2 34 PM '88
PUBLIC UTILITIES COMMISSION

The Honorable Chairman and Members
of the Hawaii Public Utilities Commission
465 South King Street
Kekuanaoa Building, 1st Floor
Honolulu, HI 96813

Dear Commissioners:

Subject: Commission's Rule 6-74-17
<u>Electric Utility System Cost Data</u>

Hawaiian Electric Company, Inc. (HECO) respectfully submits data from which avoided costs may be derived pursuant to the requirements of Commission Rule 6-74-17.

In accordance with these rules, HECO will maintain a copy of the data submitted for public inspection in its System Planning Department located at 820 Ward Avenue, Honolulu, Hawaii.

It should be emphasized that the data submitted will not, in itself, determine HECO's "avoided costs" for a specific proposal from a qualifying facility without full consideration of the factors required to be taken into account by the Commission's Rule 6-74-23.

If you or your staff have any questions regarding our data submission, please feel free to contact me.

Very truly yours,

George T. Iwahiro

Attachment

cc: C. W. Totto, Esq. (2)

HECO Response:
Section 6-74-17 (a) (2)
The Hawaiian Electric Company, Inc. (HECO) has the following plan for capacity retirements and additions during the current and succeeding ten years:

Year	Unit Capability (Megawatts) Retired	Added	Owned By:	Unit Type
1988	--	--		
1989	--	70	HECO	Combustion turbine (1)
1990	--	110	KP **	Combined cycle
1991	--	--		
1992	--	146	AES-BP	Circulating fluidized bed coal-fired boilers
1993	--	--		
1994	--	--		
1995	--	146	HECO	Circulating fluidized bed coal-fired boilers (2)
1996	--	--		
1997	--	--		
1998	--	--		

** Kalaeloa Partners, L.P.

Notes:

(1) The combustion turbine will be leased from Kalaeloa Partners, L.P. and will be the initial phase of the planned 1990 Kalaeloa Partners, L.P. combined cycle unit.

(2) This unit will not be required if adequate geothermal is committed by 1990 to be available in 1995.

There are no current plans to add load management facilities during this same period. The Company is actively participating with the Hawaii Public Utilities Commission's integrated resource planning consultant in the development of appropriate future resource plans which would further integrate demand-side and supply-side options.

Section 6-74-17
Availability of electric utility system cost data; general rule.

(a) To make available data from which avoided costs may be derived, not later than June 30, 1982, and not less often than every two years thereafter, each regulated electric utility described in section 7-74-16 shall provide to the PUC, and shall maintain for public inspection at its administrative office the following data:

(2) The electric utility's plan for the addition of capacity or load management facilities, or both by amount and type, for purchases of firm, and for capacity retirements for each year during the succeeding ten years; and

(3) The estimated capacity or load management facilities or both costs at completion of the planned capacity additions and planned capacity firm purchases, on the basis of dollars per kilowatt, and the associated energy costs of each unit operating at its most efficient point expressed in cents per kilowatt hour. These costs shall be expressed in terms of individual generating units and of individual planned firm purchases. The utility shall specify whether costs are current costs or projected costs.

HECO Response:
Section 6-74-17 (a) (3)

Year	Unit Size (MW)	Owned By:	Capacity Cost $	Term of Contract	Energy Cost ¢/KWH *	
1988	--					
1989	70	HECO	(1)	N/A	4.230	(2)
1990	110	KP **	148.68/kw-year (3)	25 years	4.034	(4)
1991	--					
1992	146	AES-BP	308.35/kw-year (5)	30 years	2.88	(6)
1993	--					
1994	--					
1995	146	HECO(7)	1,894.00/kw (8)	N/A	1.629	(9)
1996	--					
1997	--					
1998	--					

* Energy costs are in ¢/net KWH unless otherwise noted.
** Kalaeloa Partners, L.P.

Notes:

(1) HECO will be leasing a combustion turbine from Kalaeloa Partners, L.P. with rental payments to be incorporated with a Purchased Power Agreement that will take effect in 1990.

(2) Based on HECO diesel fuel price of $3.2150 per MBtu, effective 10/01/88. Note: ¢/gross KWH for fuel only

(3) This is the fixed rate specified in the contract. This charge will be adjusted at the In-Service Date for events specified in Article V, Section 5.2 C of the purchased power contract.

(4) The Energy Charge, in January 1, 1988 dollars, which explicitly includes O&M charges other than fuel, is based on charges specified in Article V, Section 5.1 A of the purchased power contract. Energy charges will be adjusted every month to reflect changes in the price paid for fuel and the Gross National Product Implicit Price Deflator. The charges will also be adjusted as specified in Sections 5.1 B, C, and D.

(5) The Capacity Charge is based on a fixed rate of $0.044 per kilowatt-hour for each hour in which the capacity is available. The cost per kilowatt is computed using the expected 80% availability factor specified in the purchased power contract.

(6) The Energy Charge, in July 1987 dollars, which explicitly includes O&M charges other than fuel, is based on charges specified in Article V, Section 5.1 A of the purchased power contract. Energy charges will be adjusted every six months at 100 percent of the change in the Gross National Product Implicit Price Deflator.

(7) This unit will not be required if adequate geothermal is committed by 1990 to be available in 1995.

(8) Based on a total cost of $276,454,500 (includes proportionate allocation of infrastructure cost) in 1988 dollars for a unit located at Kahe North.

(9) Based on 1987 coal prices, escalated to $1.791/MBTU in 1988 dollars. Note: ¢/gross KWH for fuel only

PUC Reporting Standards
Effective May 2, 1985

Filing Data Dated October 28, 1988

Notes on HECO data filed by System Planning for Section 6-74-17 (a)(2):

1. HECO capacity to be added in 1988 - 1998

   a. In an agreement dated 3/21/88, HECO agreed to lease a 70 megawatt combustion turbine from HACOA (now Kalaeloa Partners, L.P.) with a planned in-service date of August, 1989. As this agreement is not a purchased power contract, HECO is technically considered the owner of the unit (per Corporate Counsel).

   b. Per D.L. Schwartz, additional HECO generating capacity will be required in 1995 based on GEPPS run PL92 / PU868 / PB128 with additional notes dated 6/8/88. The current plan calls for a 146 megawatt, circulating fluidized bed coal-fired unit to be located at Kahe North. No other additional capacity will be required within the ten year reporting period.

      This unit could be deferred if adequate geothermal capacity is committed by 1990 to be available in 1995.

2. HECO retirements in 1988 - 1998

   There are no firm plans to retire any existing HECO units within the ten year reporting period.

3. HECO load management facilities

   There are no firm plans to install any load management facilities within the ten year reporting period.

4. Firm capacity purchased power agreements 1988 - 1998

   a. HECO and AES Barbers Point, Inc. have entered into a power purchase agreement. AES-BP will provide:

      1) Firm capacity (page 26)
         ". . . the Facility will have and maintain the capability to produce and deliver . . . at least 146,000 KW (plus or minus five (5) percent) at 0.85 lagging power factor . . ."

      2) In-service date (page 13)
         ". . . the Facility will achieve an In-Service Date on or before November 30, 1992 . . ."

b. HECO and Kalaeloa Partners, L.P. have signed a power purchase agreement that will be distributed later. Assuming that the contract wording from the preliminary agreement will remain the same, Kalaeloa will provide:

1) Firm capacity
". . . One hundred and eighty megawatts (180,000 kw) (or such other level as may be established under Section 5.2B) of capacity . . . at 0.85 lagging power Factor . . ."

2) In-Service date (page 19, page 27)
". . . Phase One is intended to be placed in commercial operation by August 30, 1989 . . ."

". . . the In-Service Date will occur no later than March 31, 1991 or twenty-seven (27) months after receipt of approval of this Agreement by the PUC or nineteen (19) months after the receipt of all construction permits . . ."

<u>Notes on HECO data filed by System Planning for Section 6-74-17 (a)(3):</u>

1. HECO capacity to be added in 1988 - 1998

a. In an agreement dated 3/21/88, HECO agreed to lease a 70 megawatt combustion turbine from HACOA (now Kalaeloa Partners, L.P.) with a planned in-service date of August, 1989.

1) The combustion turbine is actually Phase One of the Kalaeloa combined cycle unit and lease rental payments are not required during the interim period before Phase Two is completed (page 7 of Attachment 1). As a result, there are no capacity costs associated with this unit.

2) Energy costs at the most efficient point were computed using the HECO Fuel Prices effective 10/01/88, specifically the cost of Waiau diesel (including taxes and thruput) at $3.2150 per MBTU. Fuel to be burned will actually be a gaseous fuel that is expected to cost more than diesel oil on a Btu basis.

A, B, C constants were derived from preliminary data provided by Engineering dated October 17, 1988 for four load points. Engineering is currently waiting for performance data from ABB based on "agreed" fuel specifications with HIRI/ABB/HECO.

$$¢/KWH = \frac{(A + B*Load + C*Load*Load) * ¢/MBTU}{Load}$$

$$= \frac{(300.399 + 8.30983*70 + .0079428*70*70) * 321.50}{70,000}$$

$$= 4.230$$

Note: Most efficient operating point = (A/C)**0.5

b. Circulating fluidized bed coal-fired unit to be added in 1995

1) Capital cost of the circulating fluidized bed coal-fired unit is based on an IOC to J.F. Richardson, Jr. from S. Tanno dated May 16, 1988. Estimated cost is \$265,761,000, including on-site coal storage costs, plus \$10,693,500 (one-fourth of estimated \$42,774,000 for 4 units) for coal handling facilities at the dock and transportation to the Kahe site.

$$\$/KW = \frac{\$276,454,500}{146,000\ KW}$$

$$= \$1,893.52$$

2) Energy costs at the most efficient point were computed using the 1987 coal price of \$37.50/ton from an AES proposal, escalated at the DOE's forecasted deflator rate giving \$42.63/ton (\$37.07/ton plus 15% for limestone) in 1988. Using 23.802 MBTU/ton gives \$1.791/MBTU. A, B, C constants were derived using data from Engineering dated 8/20/87.

$$¢/KWH = \frac{(94.4644 + 8.45027*146 + 0.0015802*146*146) * 179.}{146,000}$$

$$= 1.629$$

2. Firm capacity purchased power agreements 1988 - 1998

a. HECO and AES Barbers Point, Inc. have entered into a power purchase agreement. Terms of the contract are:

1) Capacity Charge (page 38)
". . . shall be at a fixed rate of \$0.044 per kilowatthour for each hour in which the capacity is available. . ."

". . . AES-BP warrants and guarantees that the Facility will achieve at least an 80 percent Equivalent Availability Factor . . ." (pages 25-26)

$$\$/KW = \frac{(\$0.044\ \$/KWH * 146{,}000\ KW * 8{,}760\ Hr/Yr * 0.8)}{146{,}000\ KW}$$

$$= \$308.35$$

2) Energy Charge (page 37)
"The monthly Energy Charge in July 1987 dollars shall be:

(0.0000312487*A*A - 0.0087331*A + 3.72022) * (B/100) -

(1,460,146 * (C - 0.80292*D))

where . . ."

Leaving out the C and D load and availability penalties/incentives, the hourly energy charges would vary throughout the dispatch range of 51 MW through 146 MW. The energy charges will vary from:

(((0.0000312487*51*51) - 0.0087331*51 + 3.72022)) * (51,000/100)) / 51,000

or 3.356 ¢/KWH

to

(((0.0000312487*146*146) - 0.0087331*146 + 3.72022)) * (146,000/100)) / 146,000

or 3.111 ¢/KWH

Using data provided for the PUC hearings for the AES contract, a range of 2.88 to 5.16 ¢/kwh was used for this filing. These numbers were derived using constant loading for a 720 hour month at the following:

A = 146 MW	and	51 MW
B = 146,000 MWH	and	51,000 MWH
C = 0.84	and	0.35
D = 0.84	and	1.00

Note that the C and D factors for a constant loading of 146 MW should actually be 1.00 which would yield 2.84 ¢/kwh.

b. HECO and Kalaeloa Partners, L.P. have signed a purchased power agreement that has not yet been distributed. Terms of the contract are:

1) Capacity Charge (page 52)
"The Capacity Charge to be paid . . . shall be at a fixed rate of $148.68 per kilowatt year . . ."

2) Energy Charge (pages 49-50)
Energy charges shall be computed as follows:

(Fuel component * (LSFO Actual/LSFO Base))
+ (Non-Fuel Component * (GNPIPD current/GNPIPD base)
+ Additive Component

Using:
LSFO Actual = LSFO Base
GNPIPD current = GNPIPD base
Non-Fuel Component = 0.97 ¢/KWH
Additive Component = 0.144 ¢/KWH
Fuel Component:
7.458436 - .06425951*Load + .0003206926*Load*Load
- .000000577144*Load*Load*Load for two gas turbines

and

6.866031 - .07354662*Load + .0003659949*Load*Load
for a single gas turbine

5.594 = 7.458436 - .06425951*65 + .0003206926*65*65
- .000000577144*65*65*65 + .97 + .144

4.034 = 7.458436 - .06425951*180 + .0003206926*180*180
- .000000577144*180*180*180 + .97 + .144

ATTACHMENT 7.1B

ORMAT®

APR - 3 1989

March 31, 1989

John F. Richardson, Jr., P.E.
Executive Staff Engineer
Hawaiian Electric Company, Inc.
P.O. Box 2750
Honolulu, HI 96840-0001

VIA EXPRESS MAIL

RE: HAWAII GEOTHERMAL/INTERISLAND TRANSMISSION PROJECT RFP SOLICITATION

Dear Mr. Richardson:

I am sure you are familiar with the progress the Puna Geothermal Venture (PGV) has recently been making in the development of the first commercially operated geothermal project on the Big Island of Hawaii. Such progress has accelerated since Ormat Energy Systems, Inc. acquired the rights to develop the project.

The level of our investment demonstrates that we at Ormat are unequivocally committed to participating in any future development of the geothermal potential in the State of Hawaii. To that end, we have been approached by potential participants, very prominent companies which are certainly capable of providing the supplementary technology associated with the cable and the transmission lines, as well as the financial resources required to carry the project forward.

Consequently, and in view of the fact that the decision on the short list of bidders will be pending for some time, Ormat has proposed to all potential bidding groups that we will be standing by to provide the geothermal resource and the Ormat technology to the extent feasible. In the meantime, we will continue to concentrate on the development of the first phase and to monitor the 500 MW process.

In any event, please find enclosed our Qualifications and Experience document, which will provide you with background information on Ormat, as well as copies of our letter to the potential bidders.

Best regards,

Hezy Ram
President

HR/lks

Enclosure

35528M

ORMAT ENERGY SYSTEMS, INC.

610 East Glendale Ave., Sparks, Nevada 89431-5811 • Telephone (702) 356-9111 • Facsimile (702) 356-9125 • Telex 170030

ATTACHMENT 7.1C

MID-PACIFIC GEOTHERMAL, INC.

Exploration Development Marketing of Geothermal Resources

April 3, 1989
APR 4 1989

Mr. John F. Richardson, Jr., P.E.
Executive Staff Engineer
Hawaiian Electric Company, Inc.
P.O. Box 2750
Honolulu, Hawaii 96840

SUBJECT: Hawaii Geothermal/Interisland Transmission Project RFP Solicitation

Dear Mr. Richardson,

True Geothermal Energy Company and Mid-Pacific Geothermal, Inc., are interested in and expect to participate in, arriving at a contract with Hawaiian Electric Company to supply 500mw of geothermal electrical power from the Kilauea east rift zone for transmission to Oahu via a proposed HVDC transmission system. We have had discussions with two major corporations with the capability to organize and finance the generating and transmission components of the subject project.

Due to the limited time in which to respond to HECO's solicitation of interest letter of February 10, 1989, it was not possible to identify or commit to any particular organization or lead entity that would ultimately respond to the RFP. However, we had no objection to any respondent identifying True/Mid-Pacific as a resource producer who would cooperate in efforts leading towards development of the project, subject of course to reaching a business agreement among the participating parties. Therefore, it is possible that True/Mid-Pacific may be identified as a resource/energy producer in the organization description of more than one RFP respondent.

As to our capability to explore for and develop geothermal resources, that portion of the Kilauea east rift zone within the land surface area under lease by True/Mid-Pacific from the Estate of James Campbell (27,000 acres more or less) has been grossly estimated to have a geothermal resource potential sufficient to supply up to 400mw of electrical power. We currently have a land use permit to develop up to 100mw of power within the State mining lease area and geothermal resource subzone consisting of about 9,000 acres of the Campbell Estate property.

We foresee our participation in the project within an organizational structure that may be formed as follows:

Major Geothermal Resouce Producer - True/Mid-Pacific

Power Generating Systems - True/Mid-Pacific, Campbell Estate (at their option), and others, such as a major power plant vendor.

HVDC Transmission Systems - A major cable manufacturer; participants to be determined)

Lead Entity for Proposal including financing of generating and transmission systems - (To be determined).

In the interim, we are continuing to investigate evolving technology in geothermal resource development and power generating/transmission systems to enhance the prospects of producing and transmitting geothermal generated electricity within cost ranges that will encourage wide private sector interest and participation in this project.

We are hopeful of initiating our exploration effort by the 4th quarter of this year, subject to obtaining administrative approval of remaining documents/permits required for conducting geothermal exploration activities in the Kilauea middle east rift zone.

Very truly yours,

MID-PACIFIC GEOTHERMAL, INC.

Rod Moss
Vice President

TRUE GEOTHERMAL ENERGY CO.

Allan Kawada

cc: Estate of James Campbell
ASEA Brown Boveri
Mitsubishi Heavy Industries, Ltd.
Toyo Menka Kaisha, Ltd.

CHAPTER 8: TECHNICAL FEASIBILITY OF A MAUI TAP

The Maui Electric Company, Ltd., (MECO) is interested in determining the technical feasibility of an up to 50 MW tap on the HVDC transmission system that would allow delivery of a portion of the Project power to MECO. MECO is not requesting a Proposal to sell power to MECO at this time. Any MECO Request for Proposal would be subsequent to execution of a PPA by HECO and would be subject to HECO approval.

The material which follows is a supplement to the first seven chapters of this RFP. The section numbering system reflects this. Section 8.3.7.2, for example, supplements RFP Section 3.7.2. The Chapter 8 exhibits should be included in the appropriate Proposal, technical or commercial, as marked on the individual exhibits.

8.1 PURPOSE AND GOALS

8.1.3 MAUI ELECTRIC COMPANY SYSTEM

The Maui Electric Company, Ltd. (MECO) is a regulated public utility company that is a wholly owned subsidiary of HECO. Located on the island of Maui, MECO is responsible for providing electrical service to a population of about 90,000 residents on an island approximately 734 square miles in size.

The MECO system is presently comprised of 18 oil-fired generating units located at two sites -- Kahului and Maalaea. Firm energy is also purchased by MECO from a large sugar plantation power producer. Firm capacity, currently provided by MECO and through purchased power, totals 142 MW, which is expected to increase to 170 MW by end of 1991 when a medium speed diesel and a combustion turbine unit are expected to be in service. At that time the generation mix of the MECO system is expected to be 104 MW (61 percent) base load, 37 MW (22 percent) cycling and 29 MW (17 percent) peaking.

MECO recorded a peak demand of 124.7 MW in December, 1988 and produced a total of 651,717,860 gross kilowatt-hours in 1988. Purchased power for the same period was 94,106,156 kilowatt-hours. System load factors range from 67 percent to 69 percent on a yearly basis.

8.1.4 NATURE OF POWER REQUIREMENTS

With the improved economic climate of the mid-1980's MECO has seen a corresponding increase in peak load. While the growth rate has not returned to the levels seen before the oil crisis of the 1970's, growth is strong and is expected to continue at a moderate three percent rate.

It is estimated that MECO could purchase up to 50 MW of Project power in 1995. HECO will have first right to power produced by the Project. Any PPA with MECO will be subsequent to successful execution of a PPA by HECO.

8.3 TECHNICAL INFORMATION

8.3.6 HVDC TRANSMISSION SYSTEM

The PROPOSER is requested to determine the technical feasibility of an up to 50 MW tap on Maui. The Proposal should contain a discussion of the feasibility of such a tap. This discussion should specifically include the impact such a tap would have on the overall Project HVDC control system, both with regard to any required hardware modifications and any modifications to operating procedures. It is possible that maintaining the stability of the HVDC system to Oahu could result in relatively undesireable performance characteristics of the Maui converter terminal. If so, these should be discussed.

Figure 8.3A is a schematic representation of the geothermal power transmission system including a tap on Maui.

8.3.6.2 Converter Locations

A Maui converter terminal would logically be located along the southern shore line near the designated GRS on Maui (see Figure 3.6B). This location would provide easy access to a 69 or 138kV AC transmission line connected to the MECO system if geothermal development on Maui occurs. Such a location would be suitable whether the Maui termination was in-and-out or the DC transmission crossed Maui overland.

8.3.6.4 Converter Terminals

The Maui converter can be either bipolar or monopolar. The latter is probably appropriate in order to lessen the effect of disturbances in the Maui converter or MECO AC system on the HECO converter performance. The Maui converter will operate as an inverter. Power transfer will be from Hawaii to Maui.

Possible operating modes for the HVDC system that includes a Maui tap are:

- Monopolar metallic return - Maui tap only

8.3.6.7 HVDC Neutral Grounding System

The Maui pole current will only be about 80 amperes and this may be allowable as an unbalance on the Puna-Waimanalo line without the addition of a ground return at Maui.

It is possible that because of its low current requirement, a ground electrode can be used on Maui if a ground return is needed.

8.3.7 EXISTING AC SYSTEM CHARACTERISTICS

8.3.7.2 Electrical and System Data

System Operating Parameters

a. Voltage - kV (deviation)

	MECO
- Nominal phase-to-phase	69
- Normal minimum phase-to-phase	66
- Normal maximum phase-to-phase	73
- Emergency minimum phase-to-phase	63.2
- Emergency maximum phase-to-phase	73
- Normal negative sequence	Unknown
- Maximum phase unbalance	Unknown

b. Frequency - Hz (deviation limit)

	MECO
- Normal base	60
- Normal minimum	59.95
- Normal maximum	60.05
- Emergency minimum	58.5 (10s)
- Emergency maximum	61.5 (20s)

c. Load Shedding

Minimum frequency - unknown

Blk	Freq (Hz)	Time (s)	MVA (day)	MVA (eve)
1	59.3	10	-	3.5
2	59.2	10	-	8.5
3	59.1	-	-	3.5
4	58.7	-	-	5.5
5	58.5	-	-	10.5
6	58.0	-	-	11.0

d. Load Restoration Schedule

There is no set schedule on Maui for load pick-up. Manual reclosure is accomplished through SCADA with the lowest operating level at 59.7 Hz.

e. Approximate Short Circuit Capability

At Maalaea Substation bus (1989) at 69 kV.

Three phase fault	Maximum	6.6 kA
	Minimum	2.3 kA
Single phase-to-ground	Maximum	7.8 kA
fault	Minimum	3.1 kA

f. 1994 System Impedance

(per unit on 10 MVA base)

Positive Sequence	Z1	Maximum generation:	.00139 + j.0127
		Minimum generation:	.00247 + j.0373
Zero Sequence	Z0	Maximum generation:	.00083 + j.0067
		Minimum generation:	.00082 + j.0068

See Figure 8.3B for impedance branch data.

g. Load Flow Diagrams

Load flow data for the MECO system at peak, minimum and average load are given in Figures 8.3C, 8.3D, and 8.3E respectively.

h. One Line Diagram

The one line diagram for the MECO system is shown on Figure 8.3F.

i. Machine Data

MECO Generator Data - Figure 8.3G

MECO Turbine and Engine Data - Figure 8.3H

MECO Customer Generator Data - Figure 8.3I

j. Existing Equipment Ratings and Operating Stresses

Equipment	Rating
Transmission voltage	69 kV
Basic insulation level	
External insulation	450 kV
Internal insulation	350 kV
Surge arrester ratings	60 kV
Breaker and current rating	
Continuous	1.2 kA
Interrupting	19 kA

8.3.8 MECO MAALAEA SUBSTATION

The location of the Maui converter terminal has not been fixed. However, for Proposal purposes, the PROPOSER should assume it is located north of La Perouse Bay near Highway 37. From the Maui converter terminal three 69 kV lines (or two 138 kV lines) will be required to interconnect with the MECO system.

A preliminary sketch of the proposed interconnection substation is shown as Figure 8.3J. The PROPOSER should assume the interconnection substation is adjacent to the Maui converter terminal. Revenue metering for the power received by MECO would be at the interconnection substation.

8.4 RELIABILITY

Inclusion of a Maui tap may degrade the overall reliability of Project power deliveries to Oahu. The PROPOSER should provide a reliability assessment for Cases 1 and 2 of Section 4.5 with the Maui tap. The equivalent Chapter 4 exhibits request a reliability assessment that excludes the possible Maui tap.

Exhibit 8.4A requests a comparison of the estimated reliability for these two cases with and without the tap. Exhibits 8.4B and C request the supporting reliability documentation for Cases 1 and 2, respectively.

8.5 POWER DELIVERY AND SCHEDULE

MECO is not seeking proposals at this time for power from the Project. However, if a tap on Maui is technically feasible, MECO could at some time in the future solicit up to 50 MW of Project power. At the present time this is envisaged as baseload power. However, if the Project power can be cycled, MECO may elect to solicit proposals for cyclable power also.

8.7.1 FINANCIAL PROJECTIONS

8.7.1.1 Avoided Costs

MECO's latest avoided cost filing is included here as Attachment 8.7A.

8.7.1.6 Potential Price for Power

Section 7.1 requests cost information for the first phase and the complete Project without a Maui tap.

If the Maui tap is technically feasible, the PROPOSER should provide comparable information for a system that includes a possible Maui tap. Exhibit 8.7A requests summary level costs for the Maui tap secparately and the additional costs that would be incurred to modify the base Project to accept the tap. Separate Exhibits 8.7B, C and D should be provided for the first phase and the complete Project to support Exhibit 8.7A. Exhibits 8.7B, C and D do not need to differentiate between the direct Maui costs and the cost of modifications to the base Project.

8.8 REFERENCES FOR CHAPTER 8

1. Mountford, J.D. System Studies (4 volumes). Power Technologies, Inc. 1984

2. Mountford, J.D. HDWC Phase II-C System Studies. Power Technologies, Inc. 1987.

Maui Electric Company, Ltd. • 210 West Kamehameha Avenue • PO Box 398 • Kahului, Maui, HI 96732-0398 • (808)

ATTACHMENT 8.7A

August 1, 1988

Arden G. Henderson
President

The Honorable Chairman and Members
of the Hawaii Public Utilities Commission
465 South King Street
Kekuanaoa Building, 1st Floor
Honolulu, HI 96813

Gentlemen:

Subject: Commission's Rule 6-74-17
Electric Utility System Cost Data

Maui Electric Company, Ltd. (MECO) respectfully submits data from which avoided costs may be derived pursuant to the requirements of Commission Rule 6-74-17.

In accordance with the Commission's rules, MECO will maintain a copy of the data submitted for public inspection in Hawaiian Electric's (HECO's) System Planning Department located in HECO's Ward Avenue office at 820 Ward Avenue, Honolulu, Hawaii.

It should be emphasized that the data submitted will not, in itself, determine MECO's "avoided costs" for a specific proposal from a qualifying facility without full consideration of the factors required to be taken into account by the Commission's Rule 6-74-23.

If you or your staff have any questions regarding our data submission, please feel free to contact me.

Arden G Henderson

Attachments

cc: C. W. Totto, Esq. (2)

MECO Planned Unit Additions and Retirements (6-74-17)

1988 - 1998

Year	Unit	I/R (1)	Capacity MW	Installed $1000 (2)	Install $/KW	Energy Cost ¢/kwh (3)
1988	D12	I	13.75	15209(4)	1106	3.35
1989	D13	I	13.75	7362(5)	688	3.35
1991	D14	I	13.75	16859(6)	1226	3.35
1992	D15	I	13.75	8732	635	3.35
1994	D16	I	13.75	15178	1104	3.35
1996	D17	I	13.75	8732	635	3.35
1997	D18	I	13.75	16859	1226	3.35
1998	None					

NOTES:

1. Unit installation (I) or retirements (R)
   No retirements are planned during the period of 1988 to 1998.
2. Based on current estimated unit cost in 1988$ unless otherwise noted.
3. Energy cost are based on Maalaea diesel fuel prices eff. 6/1/88. Diesel fuel = $3.9/Mbtu.
4. D12 is a 13.75 mw diesel added in February 1988. Cost per PUC application.
5. D13 is a 13.75 mw diesel proposed to be added in June of 1989. PUC DO 9681.
6, Based on D12, D13 estimated installed cost.

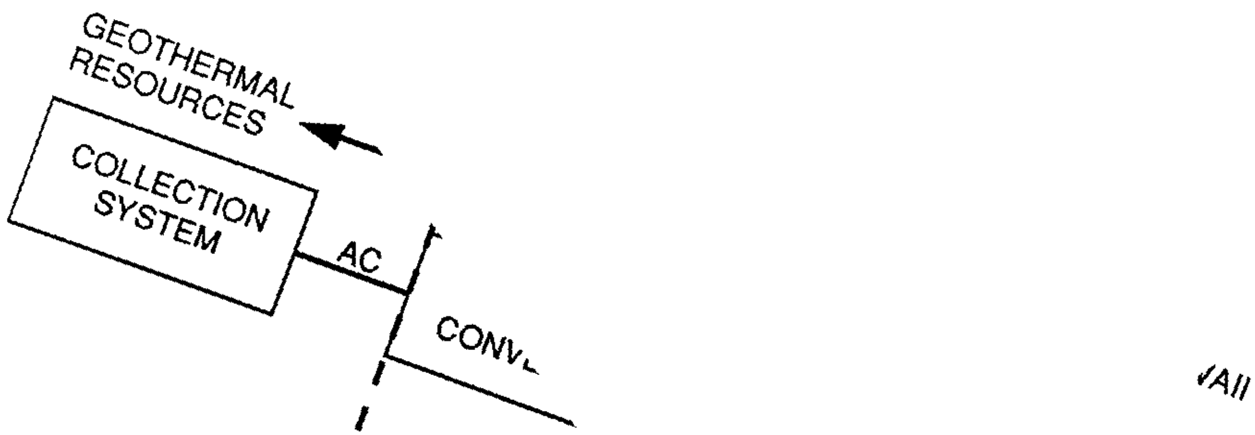


FIGURE 8.3A
GEOTHERMAL POWER TRANSMISSION SYSTEM
(INCLUDING MAUI TAP)

M0389191

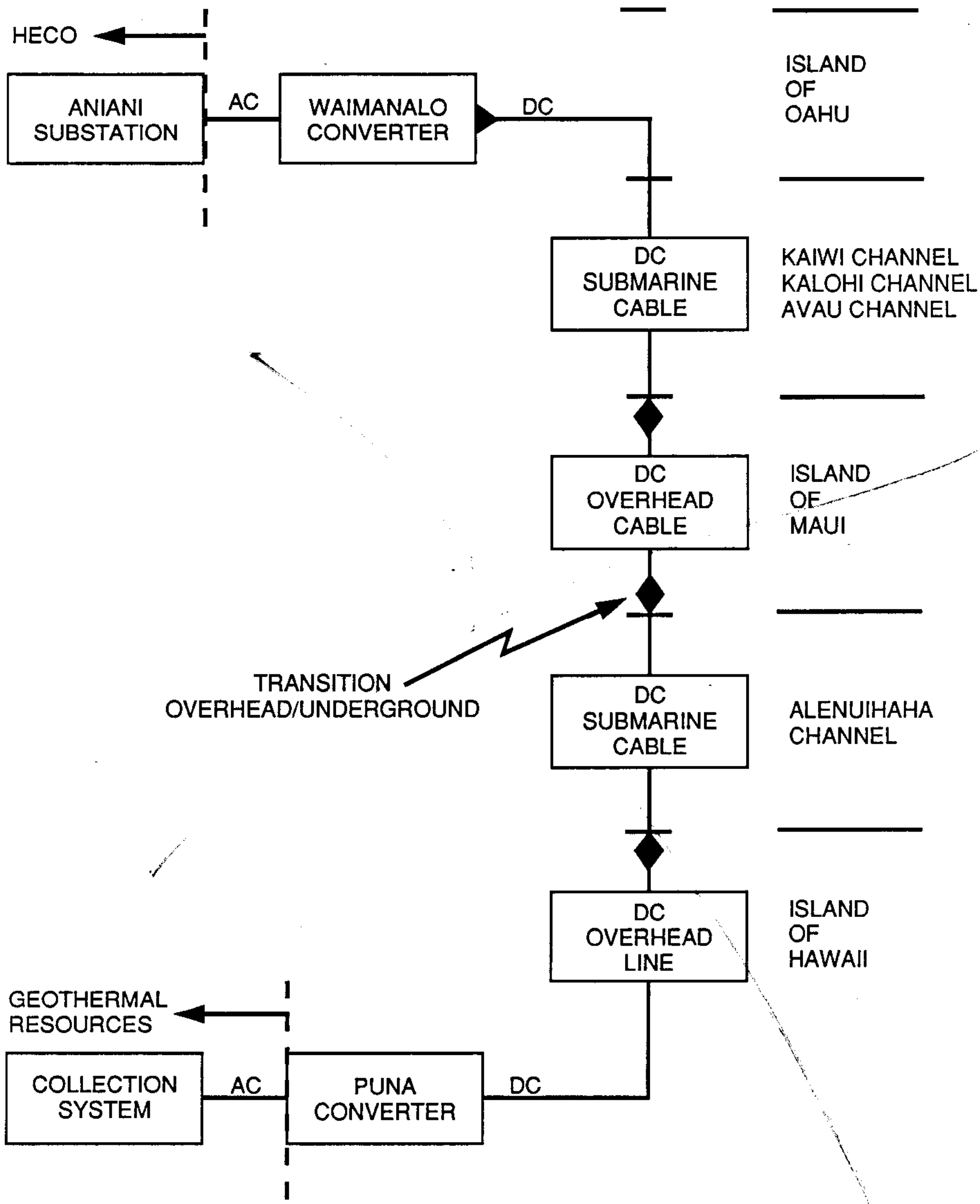
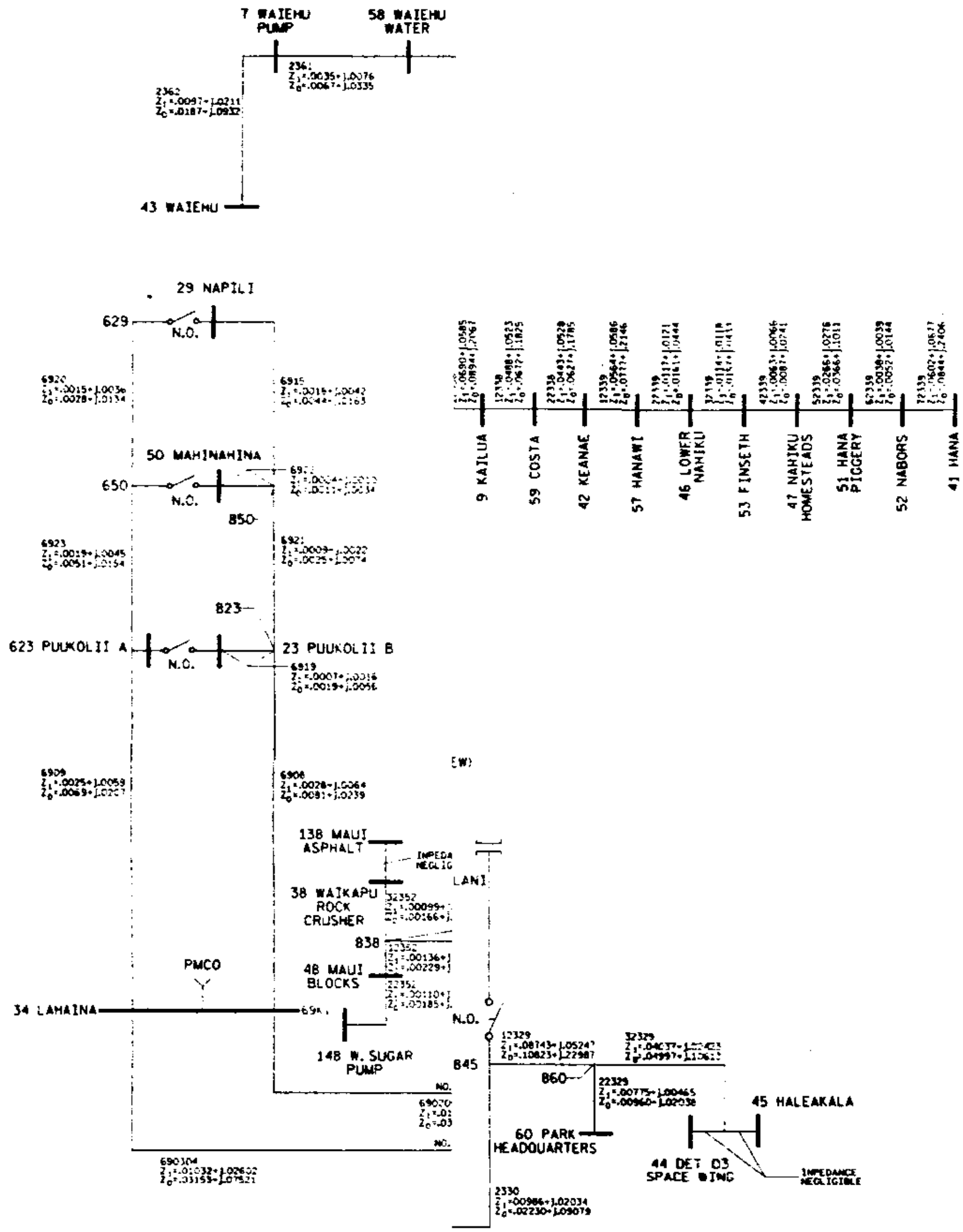


FIGURE 8.3A
GEOTHERMAL POWER TRANSMISSION SYSTEM
(INCLUDING MAUI TAP)

M0389191



NOTES:
1. LINE DATA
6909 LINE NUMBER
Z_1=.0025+j.0059 IMPEDANCE IN P.U.
2. THIS DIAGRAM REPRESENTS THE 1985 BASE CASE.
3. 10MVA BASE
4. TRANSFORMER 2725 IS ACTUALLY AN UNGROUNDED WYE ON THE 12KV SIDE. THE GROUND CONNECTION WAS BASED ON INFORMATION ORIGINALLY SUPPLIED TO SEI AND AGREES WITH THE SHORT CIRCUIT DATA

NO	DATE	REVISIONS	BY	CHK'D	APP'D

FIGURE 8.3B
MECO 69 KV
IMPEDANCE DIAGRAM

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E WED, APR 05 1989 16:24
MECO - 15MW CT ADDED AT PUUNENE; 1993 SYSTEM
CTMAX: HC&S=21MW; 1.8MVAR KANA KAHU WAIL; TIETAPS=2.5%

BUS DATA								LINE DATA									
FROM BUS	NAME	AREA ZONE	VOLT PU/KV	ANGLE	GEN MW/MVAR	LOAD MW/MVAR	SHUNT MW/MVAR	TO BUS	NAME	CKT	AREA	MW	MVAR	TRANSFORMER RATIO	TRANSFORMER ANGLE	RATING % I	RATING A MVA
200	KAHULUI 23.0	1	1.013	-2.8	0.0	0.0	0.0										
		1	23.30		0.0	0.0	0.0	3	WLUKU23 23.0	1	1	12.4	5.2			47	29
								101	KPP-1 11.5	1	1	-5.0	-1.6	1.015LK		72	7
								102	KPP-2 11.5	1	1	-5.0	-1.8	1.046LK		79	3
								103	KPP-3 11.5	1	1	-11.7	-5.3	1.046LK		91	[illegible]
								104	KPP-4 11.5	1	1	-13.4	-4.5	1.021LK		71	29
								202	KANAHA2323.0	1	1	6.9	2.2			39	19
								202	KANAHA2323.0	2	1	6.9	2.2			38	17
								202	KANAHA2323.0	3	1	9.8	4.2			34	29
202	KANAHA2323.0	1	1.004	-3.4	0.0	0.0	0.0										
		1	23.09		0.0	0.0	0.0	200	KAHULUI 23.0	1	1	-6.9	-2.1			38	17
								200	KAHULUI 23.0	2	1	-6.9	-2.1			39	19
								200	KAHULUI 23.0	3	1	-8.3	-4.1			34	29
								272	23.0	1	1	17.3	7.7			66	29
								602	KANAHA6969.0	1	1	-0.7	-1.1	1.001UN		27	5
								602	KANAHA6969.0	2	1	-0.7	-1.1	1.001UN		27	5
								602	KANAHA6969.0	3	1	-1.3	-2.1	1.001UN		24	4
								806	PUKLNJCT23.0	1	1	5.8	3.5			43	16
								819	PUUN JCT23.0	1	1	2.2	1.2			16	16
8	KAHU SUB23.0	1	0.982	-4.6	0.0	0.0	0.0										
		1	22.58		0.0	0.0	0.0	5	MAUI PIN23.0	1	1	4.2	2.5			29	25
								272	23.0	1	1	-8.5	-3.6			76	12
								272	23.0	2	1	-8.5	-3.6			76	12
								801	KAHUL A 4.16	1	1	2.9	4.1	0.974LK		171	3
								802	KAHUL B 4.16	1	1	1.3	0.8	0.970LK		109	2
								803	KAHUL C 12.5	1	1	6.7	1.7	0.899LK		94	3
								805	23.0	1	1	0.3	-1.4			12	12
								840	23.0	1	1	1.6	-0.6			14	12
236	WAIINU 23.0	1	0.987	-4.9	0.0	0.0	0.0										
		1	22.70		0.0	0.0	0.0	3	WLUKU23 23.0	1	1	2.6	1.6			11	29
								136	WAIINU B12.5	1	1	3.8	2.2	0.919LK		129	4
								270	23.0	1	1	-0.5	2.9			10	29
								436	WAIINU A4.16	1	1	0.9	0.5	0.970LK		69	2
								636	WAIINU 69.0	1	1	-6.8	-7.2	1.001UN		50	29
3	WLUKU23 23.0	1	0.983	-5.1	0.0	0.0	0.0										
		1	22.62		0.0	0.0	0.0	33	WS MILL 23.0	1	1	7.4	4.4			31	29
								200	KAHULUI 23.0	1	1	-12.2	-4.6			47	29
								236	WAIINU 23.0	1	1	-2.6	-1.6			11	29
								403	WLUKU A 4.16	1	1	1.1	0.6	0.933LK		33	2
								404	WLUKU B 4.16	1	1	1.3	0.7	0.933LK		98	2
								405	WLUKU C 12.5	1	1	5.0	0.5	0.903LK		69	8
6	PAIA 23.0	1	0.947	-4.9	0.0	0.0	0.0										
		1	21.79		0.0	0.0	0.0	406	PAIA A 4.16	1	1	1.7	1.0	0.909LK		138	2
								806	PUKLNJCT23.0	1	1	-5.6	-3.1			47	14
								916	HAIK JCT23.0	1	1	3.9	2.2			38	12

FIGURE 8.3C
MECO 1994
PEAK LOAD FLOW

1 of 3

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E WED, APR 05 1989 16 24
MECO - 15MW CT ADDED AT PUUNENE; 1993 SYSTEM
CTMAX: HC&S=21MW; 1.8MVAR KANA KAHU WAIL; TIETAPS=2.5%

(BUS DATA) FROM BUS	NAME	AREA ZONE	VOLT PU/KV	ANGLE	GEN MW/MVAR	LOAD MW/MVAR	SHUNT MW/MVAR	(LINE DATA) TO BUS	NAME	CKT	AREA	MW	MVAR	TRANSFORMER RATIO	TRANSFORMER ANGLE	RATING I	%
602	KANAHA6969.0	1	1.025	-2.7	0.0	0.0	0.0										
		1	70.73		0.0	0.0	0.0	202	KANAHA2323.0	1	1	0.7	1.1	1.001LK		27	
								202	KANAHA2323.0	2	1	0.7	1.1	1.001LK		27	
								202	KANAHA2323.0	3	1	1.3	2.4	1.001LK		24	
								204	KANAH B 12.5	1	1	3.9	2.2	0.972UN		115	
								205	KANAH C 12.5	1	1	6.9	2.1	0.972UN		94	
								401	PUUNENEA69.0	1	1	-29.1	-14.3			56	48
								617	PUKLN69 69.0	1	1	15.6	5.7			26	
4	PUUNENE 69.0	1	1.030	-2.4	21.0	7.7	0.0										
		2	71.07		2.2R	3.7	0.0	2	PUNENE1313.8	1	1	-14.5	-9.7	1.025LK		85	
								401	PUUNENEA69.0	1	1	29.2	14.4			51	
								402	PUUNENEB69.0	1	1	-1.3	-6.2			10	
39	MAALAEA 69.0	1	1.040	-2.6	0.0	0.0	0.0										
		1	71.74		0.0	0.0	0.0	34	LAHAINA 69.0	1	1	28.0	12.6			48	
								34	LAHAINA 69.0	2	1	26.8	12.3			46	
								35	KIHEI 69.0	1	1	22.2	5.4			80	
								105	MPP-123 4.16	1	1	-7.5	-3.9	1.066LK		77	
								106	MPP-458 4.16	1	1	-16.8	-8.8	1.066LK		80	
								107	MPP-679 4.16	1	1	-16.8	-8.8	1.066LK		80	
								108	MPP-10116.56	1	1	-25.0	-12.9	1.000LK		79	
								109	MPP-12136.56	1	1	-25.0	-13.5	1.000LK		80	
								110	MPP-X1X24.16	1	1	-5.0	-2.6	1.040LK		73	
								139	MAALA 1212.5	1	1	10.9	6.6	0.975LK		163	
								402	PUUNENEB69.0	1	1	1.4	6.0			12	48
								636	WAIINU 69.0	1	1	6.8	7.6			16	
636	WAIINU 69.0	1	1.029	-2.8	0.0	0.0	0.0										
		1	71.00		0.0	0.0	0.0	39	MAALAEA 69.0	1	1	-6.8	-7.7			16	32
								236	WAIINU 23.0	1	1	6.8	7.7	1.001LK		50	
34	LAHAINA 69.0	1	0.981	-5.9	0.0	0.0	0.0										
		1	67.72		0.0	0.0	0.0	39	MAALAEA 69.0	1	1	-27.1	-10.8			48	
								39	MAALAEA 69.0	2	1	-26.0	-10.6			46	
								134	LAHAIN 112.5	1	1	7.4	3.3	0.971LK		111	
								343	PMCO1-2 12.5	1	1	0.0	0.0	0.971LK		0	
								343	PMCO1-2 12.5	2	1	0.0	0.0	0.971LK		0	
								623	PUUKA 6969.0	1	1	8.8	3.8			16	
								823	PUUKB 6969.0	1	1	28.0	10.2			49	
								834	LAHAIN 412.5	1	1	9.8	4.0	0.900LK		132	
29	NAPILI B69.0	1	0.962	-7.3	0.0	0.0	0.0										
		1	66.39		0.0	0.0	0.0	129	NAPILB1212.5	1	1	8.8	0.0	0.950LK		123	
								850	69.0	1	1	-8.8	0.0			15	
35	KIHEI 69.0	1	1.014	-3.6	0.0	0.0	0.0										
		1	69.93		0.0	0.0	0.0	25	WAILEA 69.0	1	1	12.6	3.6			21	
								39	MAALAEA 69.0	1	1	-21.7	-5.1			80	
								135	KIHEI 1212.5	1	1	9.2	1.4	0.975LK		122	
25	WAILEA 69.0	1	1.007	-4.0	0.0	0.0	0.0										
		1	69.48		0.0	0.0	0.0	35	KIHEI 69.0	1	1	-12.5	-3.7			21	
								125	WAILEA A12.5	1	1	8.4	0.7	0.953LK		112	
								225	WAILEA B12.5	1	1	3.0	1.4	0.950LK		44	
								855	KULA TP 69.0	1	1	1.1	1.6			3	

2of3

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E WED, APR 05 1989 16:24
MECO - 15MW CT ADDED AT PUUNENE; 1993 SYSTEM
CTMAX: HC&S=21MW; 1.8MVAR KANA KAHU WAIL; TIETAPS=2.5%

BUS DATA								LINE DATA									
FROM BUS	NAME	AREA ZONE	VOLT PU/KV	ANGLE	GEN MW/MVAR	LOAD MW/MVAR	SHUNT MW/MVAR	TO BUS	NAME	CKT	AREA	MW	MVAR	TRANSFORMER RATIO	TRANSFORMER ANGLE	RATING A %I	MVA
617	PUKLN69 69.0	1	1.007	-3.7	0.0	0.0	0.0										
		1	69.48		0.0	0.0	0.0	217	PUKLN23 23.0	1	1	5.2	2.2	0.954LK		75	8
								602	KANAHA6969.0	1	1	-15.4	-5.6			27	52
								613	KULA 69 69.0	1	1	4.9	0.3			8	52
								817	PUKLN A 12.5	1	1	1.8	0.9	0.936LK		54	4
								917	PUKLN B 12.5	1	1	3.5	1.8	0.936LK		105	4

3 of 3

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E WED, APR 05 1989 17:25
MECO - 15MW CT ADDED AT PUUNENE; 1993 SYSTEM
CTMIN: 3.6MVAR AT NAPILI; TIETAPS=2.5%

BUS DATA								LINE DATA									
FROM BUS	NAME	AREA ZONE	VOLT PU/KV	ANGLE	GEN MW/MVAR	LOAD MW/MVAR	SHUNT MW/MVAR	TO BUS	NAME	CKT	AREA	MW	MVAR	TRANSFORMER RATIO	TRANSFORMER ANGLE	RATING A %I	RATING A MVA
200	KAHULUI 23.0	1	1.019	-2.4	0.0	0.0	0.0										
		1	23.44		0.0	0.0	0.0	3	WLUKU23 23.0	1	1	8.4	3.7			32	29
								101	KPP-1 11.5	1	1	0.0	0.0	1.015LK		0	7
								102	KPP-2 11.5	1	1	-5.6	-2.2	1.046LK		72	8
								103	KPP-3 11.5	1	1	-11.7	-5.2	1.046LK		78	16
								104	KPP-4 11.5	1	1	-11.8	-2.9	1.021LK		61	29
								202	KANAHA2323.0	1	1	6.1	1.6			33	19
								202	KANAHA2323.0	2	1	6.1	1.6			33	19
								202	KANAHA2323.0	3	1	7.8	3.4			29	29
202	KANAHA2323.0	1	1.012	-2.9	0.0	0.0	0.0										
		1	23.27		0.0	0.0	0.0	200	KAHULUI 23.0	1	1	-6.1	-1.6			33	19
								200	KAHULUI 23.0	2	1	-6.1	-1.6			33	19
								290	KAHULUI 23.0	3	1	-7.8	-3.3			29	29
								272	23.0	1	1	10.3	3.8			38	29
								602	KANAHA6969.0	1	1	1.5	0.2	1.001UN		32	5
								602	KANAHA6969.0	2	1	1.5	0.2	1.001UN		32	5
								602	KANAHA6969.0	3	1	3.0	0.3	1.001UN		28	11
								806	PUKLNJCT23.0	1	1	2.6	1.4			19	16
								819	PUUN JCT23.0	1	1	1.1	0.6			7	16
8	KAHU SUB23.0	1	1.000	-3.7	0.0	0.0	0.0										
		1	22.99		0.0	0.0	0.0	5	MAUI PIN23.0	1	1	2.0	1.2			9	25
								272	23.0	1	1	-5.1	-1.8			44	12
								272	23.0	2	1	-5.1	-1.8			44	12
								801	KAHUL A 4.16	1	1	1.4	1.0	0.974LK		58	3
								802	KAHUL B 4.16	1	1	0.6	0.3	0.970LK		46	2
								803	KAHUL C 12.5	1	1	3.2	1.7	0.899LK		48	3
								805	23.0	1	1	1.3	-0.5			11	12
								840	23.0	1	1	1.9	-0.1			15	12
236	WAIINU 23.0	1	0.999	-4.1	0.0	0.0	0.0										
		1	22.97		0.0	0.0	0.0	3	WLUKU23 23.0	1	1	-1.4	0.4			3	29
								136	WAIINU B12.5	1	1	1.8	1.0	0.919LK		55	4
								270	23.0	1	1	-2.4	1.0			9	29
								436	WAIINU A4.16	1	1	0.4	0.2	0.970LK		32	1
								636	WAIINU 69.0	1	1	1.5	-2.6	1.001UN		15	29
3	WLUKU23 23.0	1	0.999	-3.9	0.0	0.0	0.0										
		1	22.97		0.0	0.0	0.0	33	WS MILL 23.0	1	1	3.5	2.0			14	29
								200	KAHULUI 23.0	1	1	-8.4	-3.4			32	29
								236	WAIINU 23.0	1	1	1.4	-0.4			5	29
								403	WLUKU A 4.16	1	1	0.5	0.3	0.933LK		38	2
								404	WLUKU B 4.16	1	1	0.6	0.3	0.933LK		45	2
								405	WLUKU C 12.5	1	1	2.4	1.2	0.903LK		36	3
6	PAIA 23.0	1	0.987	-3.7	0.0	0.0	0.0										
		1	22.71		0.0	0.0	0.0	406	PAIA A 4.16	1	1	0.8	0.4	0.909LK		62	2
								806	PUKLNJCT23.0	1	1	-2.6	-1.4			21	14
								816	HAIK JCT23.0	1	1	1.8	0.9			16	12

FIGURE 8.3D
MECO MINIMUM
LOAD FLOW

1 of 3

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E WED, APR 05 1989 17:25
MECO - 15MW CT ADDED AT PUUNENE; 1993 SYSTEM
CTMIN: 3.6MVAR AT NAPILI; TIETAPS=2.5%

BUS DATA								LINE DATA									
FROM BUS	NAME	AREA ZONE	VOLT PU/KV	ANGLE	GEN MW/MVAR	LOAD MW/MVAR	SHUNT MW/MVAR	TO BUS	NAME	CKT	AREA	MW	MVAR	TRANSFORMER RATIO	TRANSFORMER ANGLE	RATING %I	RATING MVA
602	KANAHA6969.0	1	1.011	-4.5	0.0	0.0	0.0										
		1	69.74		0.0	0.0	0.0	202	KANAHA2323.0	1	1	-1.5	-0.1	1.001LK		32	[illegible]
								202	KANAHA2323.0	2	1	-1.5	-0.1	1.001LK		32	[illegible]
								202	KANAHA2323.0	3	1	-3.0	-0.2	1.001LK		28	[illegible]
								204	KANAH B 12.5	1	1	1.8	0.9	0.972UN		54	[illegible]
								205	KANAH C 12.5	1	1	3.3	1.7	0.972UN		49	[illegible]
								401	PUUNENEA69.0	1	1	-7.0	-5.0			18	[illegible]
								617	PUKLN69 69.0	1	1	7.9	2.7			13	[illegible]
4	PUUNENE 69.0	1	1.012	-4.4	12.0	3.6	0.0										
		2	69.85		3.0H	1.7	0.0	2	PUNENE1313.8	1	1	0.0	0.0	1.025LK		0	[illegible]
								401	PUUNENEA69.0	1	1	7.0	4.9			14	[illegible]
								402	PUUNENEB69.0	1	1	1.4	-3.7			6	[illegible]
39	MAALAEA 69.0	1	1.017	-4.7	0.0	0.0	0.0										
		1	70.14		0.0	0.0	0.0	34	LAHAINA 69.0	1	1	13.0	3.0			21	[illegible]
								34	LAHAINA 69.0	2	1	12.4	3.0			20	[illegible]
								35	KIHEI 69.0	1	1	9.9	4.7			39	[illegible]
								105	MPP-123 4.16	1	1	0.0	0.0	1.066LK		0	[illegible]
								106	MPP-458 4.16	1	1	0.0	0.0	1.066LK		0	[illegible]
								107	MPP-679 4.16	1	1	0.0	0.0	1.066LK		0	[illegible]
								108	MPP-10116.56	1	1	-12.5	-6.8	1.000LK		41	[illegible]
								109	MPP-12136.56	1	1	-25.0	-12.6	1.000LK		80	[illegible]
								110	MPP-X1X24.16	1	1	0.0	0.0	1.040LK		0	[illegible]
								139	MAALA 1212.5	1	1	5.1	2.8	0.975LK		77	[illegible]
								402	PUUNENEB69.0	1	1	-1.4	3.4			8	[illegible]
								636	WAIINU 69.0	1	1	-1.5	2.5			5	[illegible]
636	WAIINU 69.0	1	1.015	-4.5	0.0	0.0	0.0										
		1	70.01		0.0	0.0	0.0	39	MAALAEA 69.0	1	1	1.5	-2.7			5	[illegible]
								236	WAIINU 23.0	1	1	-1.5	2.7	1.001LK		15	[illegible]
34	LAHAINA 69.0	1	0.996	-6.4	0.0	0.0	0.0										
		1	68.69		0.0	0.0	0.0	39	MAALAEA 69.0	1	1	-12.8	-3.0			21	[illegible]
								39	MAALAEA 69.0	2	1	-12.3	-3.0			21	[illegible]
								134	LAHAIN 112.5	1	1	3.5	1.4	0.971LK		51	
								343	PMC01-2 12.5	1	1	0.0	0.0	0.971LK		0	[illegible]
								343	PMC01-2 12.5	2	1	0.0	0.0	0.971LK		0	[illegible]
								623	PUUKA 6969.0	1	1	4.2	1.4			7	[illegible]
								823	PUUKB 6969.0	1	1	13.2	1.5			22	[illegible]
								834	LAHAIN 412.5	1	1	4.2	1.7	0.900LK		51	[illegible]
29	NAPILI B69.0	1	0.990	-7.1	0.0	0.0	0.0										
		1	68.34		0.0	0.0	0.0	129	NAPILB1212.5	1	1	4.2	-2.5	0.959LK		66	
								850	69.0	1	1	-4.2	2.5			8	[illegible]
35	KIHEI 69.0	1	1.002	-5.0	0.0	0.0	0.0										
		1	69.15		0.0	0.0	0.0	25	WAILEA 69.0	1	1	5.4	2.4			10	[illegible]
								39	MAALAEA 69.0	1	1	-9.8	-4.7			39	[illegible]
								135	KIHEI 1212.5	1	1	4.3	2.3	0.975LK		66	[illegible]
25	WAILEA 69.0	1	0.999	-5.2	0.0	0.0	0.0										
		1	68.91		0.0	0.0	0.0	35	KIHEI 69.0	1	1	-5.4	-2.5			10	[illegible]
								125	WAILEA A12.5	1	1	4.0	2.1	0.953LK		59	[illegible]
								225	WAILEA B12.5	1	1	1.4	0.6	0.950LK		21	[illegible]
								855	KULA TP 69.0	1	1	0.0	-0.2			0	[illegible]

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E   WED. APR 05 1989 17:25
MECO - 15MW CT ADDED AT PUUNENE; 1993 SYSTEM
CTMIN: 3.6MVAR AT NAPILI; TIETAPS=2.5%

BUS DATA								LINE DATA									
FROM BUS	NAME	AREA ZONE	VOLT PU/KV	ANGLE	GEN MW/MVAR	LOAD MW/MVAR	SHUNT MW/MVAR	TO BUS	NAME	CKT	AREA	MW	MVAR	TRANSFORMER RATIO	TRANSFORMER ANGLE	RATING A %I	RATING A MVA
617	PUKLN69 69.0	1	1.002	-5.0	0.0	0.0	0.0										
		1	69.13		0.0	0.0	0.0	217	PUKLN23 23.0	1	1	2.4	0.8	0.954LK		34	8
								602	KANAHA6969.0	1	1	-7.8	-2.9			14	52
								613	KULA 69 69.0	1	1	2.8	0.9			5	62
								817	PUKLN A 12.5	1	1	0.8	0.4	0.936LK		25	4
								917	PUKLN B 12.5	1	1	1.7	0.8	0.936LK		49	4

363

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E WED, APR 05 1989 17:25
MECO - 15MW CT ADDED AT PUUNENE; 1993 SYSTEM
CTDAY: 1.8MVAR KANA KAHU WAIL; TIETAPS=2.5%

BUS DATA								LINE DATA									
FROM BUS	NAME	AREA ZONE	VOLT PU/KV	ANGLE	GEN MW/MVAR	LOAD MW/MVAR	SHUNT MW/MVAR	TO BUS	NAME	CKT	AREA	MW	MVAR	TRANSFORMER RATIO	TRANSFORMER ANGLE	RATING A %I	RATING A MVA
200	KAHULUI 23.0	1	1.020	-2.3	0.0	0.0	0.0										
		1	23.45		0.0	0.0	0.0	3	WLUKU23 23.0	1	1	11.2	4.4			42	29
								101	KPP-1 11.5	1	1	-5.9	-1.5	1.015LK		71	7
								102	KPP-2 11.5	1	1	-5.0	-2.2	1.046LK		71	8
								103	KPP-3 11.5	1	1	-11.7	-5.1	1.046LK		73	15
								104	KPP-4 11.5	1	1	-11.0	-2.8	1.021LK		57	20
								202	KANAHA2323.0	1	1	6.6	1.8			35	19
								202	KANAHA2323.0	2	1	6.6	1.8			35	19
								202	KANAHA2323.0	3	1	8.4	3.6			31	29
202	KANAHA2323.0	1	1.011	-2.8	0.0	0.0	0.0										
		1	23.26		0.0	0.0	0.0	200	KAHULUI 23.0	1	1	-6.5	-1.7			35	19
								200	KAHULUI 23.0	2	1	-6.5	-1.7			35	19
								200	KAHULUI 23.0	3	1	-8.4	-3.5			31	29
								272	23.0	1	1	15.5	6.1			58	29
								602	KANAHA6969.0	1	1	-0.3	-0.8	1.001UN		19	5
								602	KANAHA6969.0	2	1	-0.3	-0.8	1.001UN		19	5
								602	KANAHA6969.0	3	1	-0.7	-1.6	1.001UN		17	11
								806	PUKLNJCT23.0	1	1	5.2	3.0			38	15
								819	PUUN JCT23.0	1	1	2.0	1.1			14	15
8	KAHU SUB23.0	1	0.993	-3.9	0.0	0.0	0.0										
		1	22.84		0.0	0.0	0.0	5	MAUI PIN23.0	1	1	3.8	2.3			18	25
								272	23.0	1	1	-7.7	-2.8			67	12
								272	23.0	2	1	-7.7	-2.8			67	12
								801	KAHUL A 4.16	1	1	2.6	3.0	0.974LK		134	3
								802	KAHUL B 4.16	1	1	1.1	0.7	0.970LK		89	2
								803	KAHUL C 12.5	1	1	6.1	1.2	0.899LK		83	8
								805	23.0	1	1	0.3	-1.1			9	12
								840	23.0	1	1	1.4	-0.4			12	12
236	WAIINU 23.0	1	0.997	-4.2	0.0	0.0	0.0										
		1	22.93		0.0	0.0	0.0	3	WLUKU23 23.0	1	1	2.3	1.4			9	29
								136	WAIINU B12.5	1	1	3.5	2.0	0.919LK		106	4
								270	23.0	1	1	-0.4	2.3			8	27
								436	WAIINU A4.16	1	1	9.3	0.4	0.970LK		62	2
								636	WAIINU 69.0	1	1	-6.2	-6.1	1.001UN		44	20
3	WLUKU23 23.0	1	0.994	-4.3	0.0	0.0	0.0										
		1	22.86		0.0	0.0	0.0	33	WS MILL 23.0	1	1	6.7	3.9			27	29
								200	KAHULUI 23.0	1	1	-11.1	-3.9			42	29
								236	WAIINU 23.0	1	1	-2.3	-1.4			9	29
								403	WLUKU A 4.16	1	1	1.0	0.5	0.933LK		74	2
								404	WLUKU B 4.16	1	1	1.2	0.6	0.933LK		88	2
								405	WLUKU C 12.5	1	1	4.6	0.2	0.903LK		61	8
6	PAIA 23.0	1	0.962	-4.2	0.0	0.0	0.0										
		1	22.12		0.0	0.0	0.0	406	PAIA A 4.16	1	1	1.5	0.9	0.909LK		123	2
								806	PUKLNJCT23.0	1	1	-5.0	-2.8			42	14
								816	HAIK JCT23.0	1	1	3.5	1.9			33	12

FIGURE 8.3E
MECO 1993 AVERAGE LOAD FLOW

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E WED, APR 05 1989 17:25
MECO - 15MW CT ADDED AT PUUNENE; 1993 SYSTEM
CTDAY: 1.8MVAR KANA KAHU WAIL; TIETAPS=2.5%

BUS DATA								LINE DATA						TRANSFORMER		RATING	
FROM BUS	NAME	AREA ZONE	VOLT PU/KV	ANGLE	GEN MW/MVAR	LOAD MW/MVAR	SHUNT MW/MVAR	TO BUS	NAME	CKT	AREA	MW	MVAR	RATIO	ANGLE	%I	M...
602	KANAHA6969.0	1	1.028	-2.5	0.0	0.0	0.0										
		1	70.93		0.0	0.0	0.0	202	KANAHA2323.0	1	1	0.3	0.8	1.001LK		19	
								202	KANAHA2323.0	2	1	0.3	0.8	1.001LK		19	
								202	KANAHA2323.0	3	1	0.7	1.7	1.001LK		17	
								204	KANAH B 12.5	1	1	3.5	1.9	0.972UN		103	
								205	KANAH C 12.5	1	1	6.2	1.7	0.972UN		84	
								401	PUUNENEA69.0	1	1	-24.4	-11.9			55	
								617	PUKLN69 69.0	1	1	13.4	5.0			23	
4	PUUNENE 69.0	1	1.032	-2.3	12.0	7.0	0.0										
		2	71.23		3.0H	3.3	0.0	2	PUNENE1313.8	1	1	-14.5	-7.9	1.025LK		80	
								401	PUUNENEA69.0	1	1	24.5	11.9			43	
								402	PUUNENEB69.0	1	1	-4.9	-4.4			10	
39	MAALAEA 69.0	1	1.042	-2.1	0.0	0.0	0.0										
		1	71.91		0.0	0.0	0.0	34	LAHAINA 69.0	1	1	25.2	10.5			43	
								34	LAHAINA 69.0	2	1	24.1	10.2			41	
								35	KIHEI 69.0	1	1	20.8	3.7			74	
								105	MPP-123 4.16	1	1	-7.5	-3.1	1.066LK		74	
								106	MPP-458 4.16	1	1	-16.8	-8.4	1.066LK		80	
								107	MPP-679 4.16	1	1	-16.8	-7.4	1.066LK		78	
								108	MPP-10116.56	1	1	-25.0	-10.7	1.000LK		76	
								109	MPP-12136.56	1	1	-25.0	-11.2	1.000LK		76	
								110	MPP-X1X24.16	1	1	0.0	0.0	1.040LK		0	
								139	MAALA 1212.5	1	1	9.8	5.9	0.975LK		146	
								402	PUUNENEB69.0	1	1	5.0	4.2			13	
								636	WAIINU 69.0	1	1	6.2	6.4			14	
636	WAIINU 69.0	1	1.033	-2.3	0.0	0.0	0.0										
		1	71.27		0.0	0.0	0.0	39	MAALAEA 69.0	1	1	-6.2	-6.5			14	
								236	WAIINU 23.0	1	1	6.2	6.5	1.001LK		44	
34	LAHAINA 69.0	1	0.992	-5.1	0.0	0.0	0.0										
		1	68.44		0.0	0.0	0.0	39	MAALAEA 69.0	1	1	-24.5	-9.1			43	
								39	MAALAEA 69.0	2	1	-23.5	-9.0			41	
								134	LAHAIN 112.5	1	1	6.7	3.0	0.971LK		99	
								343	PMC01-2 12.5	1	1	0.0	0.0	0.971LK		0	
								343	PMC01-2 12.5	2	1	0.0	0.0	0.971LK		0	
								623	PUUKA 6969.0	1	1	7.9	3.3			14	
								823	PUUKB 6969.0	1	1	25.3	8.3			44	
								834	LAHAIN 412.5	1	1	8.9	3.5	0.900LK		119	
29	NAPILI B69.0	1	0.976	-6.3	0.0	0.0	0.0										
		1	67.32		0.0	0.0	0.0	129	NAPILB1212.5	1	1	8.0	-0.6	0.950LK		110	
								850	69.0	1	1	-8.0	0.6			13	
35	KIHEI 69.0	1	1.019	-3.1	0.0	0.0	0.0										
		1	70.32		0.0	0.0	0.0	25	WAILEA 69.0	1	1	12.1	2.6			20	
								39	MAALAEA 69.0	1	1	-20.4	-3.4			74	
								135	KIHEI 1212.5	1	1	8.3	0.8	0.975LK		109	
25	WAILEA 69.0	1	1.014	-3.5	0.0	0.0	0.0										
		1	69.94		0.0	0.0	0.0	35	KIHEI 69.0	1	1	-12.0	-2.7			20	
								125	WAILEA A12.5	1	1	7.6	0.1	0.953LK		100	
								225	WAILEA B12.5	1	1	2.7	1.2	0.950LK		39	
								855	KULA TP 69.0	1	1	1.7	1.3			3	

2 of 3

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E WED, APR 05 1989 17:25
MECO - 15MW CT ADDED AT PUUNENE; 1993 SYSTEM
CTDAY: 1.8MVAR KANA KAHU WAIL; TIETAPS=2.5%

BUS DATA								LINE DATA									
FROM BUS	NAME	AREA ZONE	VOLT PU/KV	ANGLE	GEN MW/MVAR	LOAD MW/MVAR	SHUNT MW/MVAR	TO BUS	NAME	CKT	AREA	MW	MVAR	TRANSFORMER RATIO	TRANSFORMER ANGLE	RATING A %I	RATING A MVA
617	PUKLN69 69.0	1	1.013	-3.4	0.0	0.0	0.0										
		1	69.88		0.0	0.0	0.0	217	PUKLN23 23.0	1	1	4.7	1.9	0.954LK		67	3
								602	KANAHA6969.0	1	1	-13.2	-5.9			23	62
								613	KULA 69 69.0	1	1	3.7	0.7			6	62
								817	PUKLN A 12.5	1	1	1.6	0.8	0.936LK		48	4
								917	PUKLN B 12.5	1	1	3.2	1.6	0.936LK		94	4

3 of 3

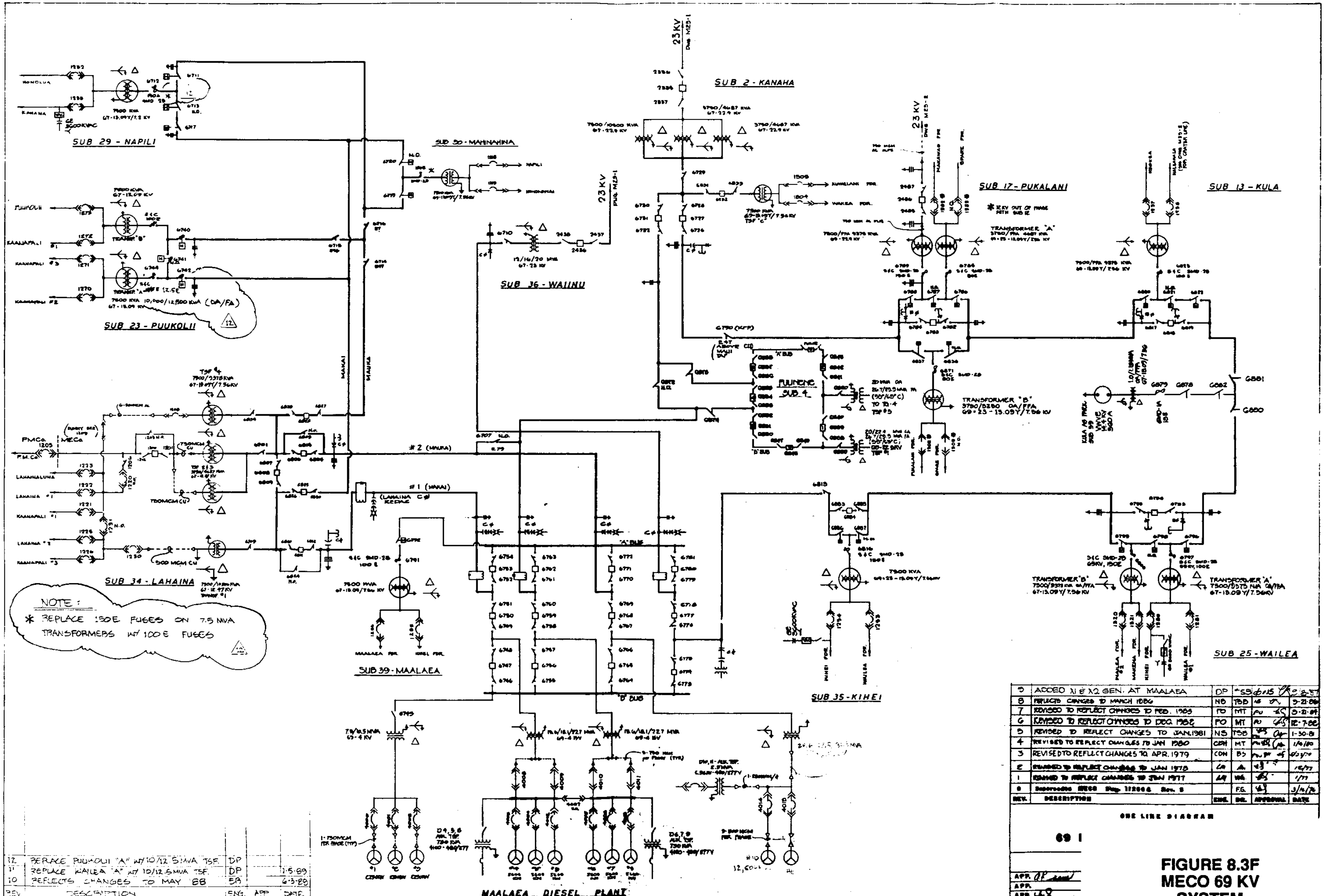


FIGURE 8.3F
MECO 69 KV SYSTEM

AUI ELECTRIC CO., LTD. - GENERATOR DATA - 1993

LANT	DATE OF COMMERCIAL OPERATION	NAMEPLATE MAXIMUM RATING KW	NAMEPLATE MAXIMUM RATING KVA	PSI	MIN RATING KW	RATED KV	WR^2 LB-FT^2	P.F.	IF	SCR	$I_2^2 T$	PERCENT REACTANCE NAMEPLATE KVA BASE XD	X'D	X''D	XO	PERCENT RATED KV 10 MVA BASE XD	X'D	X''D	XO
:AHULUI																			
UNIT 1	1948	5000	6250	A	2000	11.5	5000	.80	270		30	116	16.3	8.2	1.8	186	26.1	13.1	2.88
INIT 2	1949	5000	6250	A	2000	11.5	5000	.80	270		30	116	16.3	8.2	1.8	186	26.1	13.1	2.88
INIT 3	1954	11500	13529	A	2000	11.5	10800	.85	231		30	146	17.7	11.1	5.0	108	13.1	8.2	3.70
UNIT 4	1966	12500	15625	A	2000	11.5	7840	.80	165		30	187	15.5	11.0	3.8	120	9.9	7.0	2.43
MAALAEA		2 HR O.L.																	
)IESEL 1	12/23/71	2750	3440	A	550	4.16	12830	.80	105	.62	40	176	46.2	29.8	11.7	512	134	86.6	34.0
)IESEL 2	7/21/72	2750	3440	A	550	4.16	12830	.80	105	.62	40	176	46.2	29.8	11.7	512	134	86.6	34.0
DIESEL 3	9/14/72	2750	3440	A	550	4.16	12830	.80	105	.62	40	176	46.2	29.8	11.7	512	134	86.6	34.0
)IESEL 4	11/01/73	6160	7000(1)	A	0	4.16	200000	.80		.70	40	163 E	35.0	19.0	5.0	233	50.0	27.1	7.1
												163 I	40.0	22.0	6.5	233	57.1	31.4	9.3
DIESEL 5	12/01/73	6160	7000(1)	A	0	4.16	200000	.80		.70	40	163 E	35.0	19.0	5.0	233	50.0	27.1	7.1
												163 I	40.0	22.0	6.5	233	57.1	31.4	9.3
)IESEL 6	3/07/75	6160	7000(1)	A	0	4.16	200000	.80		.70	40	163 E	35.0	19.0	5.0	233	50.0	27.1	7.1
)IESEL 7	8/11/75	6160	7000(1)	A	0	4.16	200000	.80		.70	40	163 E	35.0	19.0	5.0	233	50.0	27.1	7.1
DIESEL 8	11/28/77	6160	7000(1)	A	0	4.16	170000	.80		.73	40	138 E	28.1	18.2	6.5	197	40.1	26.0	9.3
)IESEL 9	7/31/78	6160	7000(1)	A	0	4.16	170000	.80		.73	40	138 E	28.1	18.2	6.5	197	40.1	26.0	9.3
												154 I	30.0	18.9	6.5	220	42.9	27.0	9.3
DIESEL 10	12/31/79	13750	15625(2)	A	4000	6.90	400000	.80		.80	40	160 E	32.6	19.4	10.8	102	20.9	12.4	6.9
DIESEL 11	7/16/80	13750	15625(2)	A	4000	6.90	400000	.80		.80	40	160 E	32.6	19.4	10.8	102	20.9	12.4	6.9
DIESEL X1	03/04/87	2750	3440	A	550	4.16	12830	.80	105	.62	40	176	46.2	29.8	11.7	512	134	86.6	34.0
DIESEL X2	03/04/87	2750	3440	A	550	4.16	12830	.80	105	.62	40	176	46.2	29.8	11.7	512	134	86.6	34.0
DIESEL 12	1988	13750	15625(2)	A	4000	6.90	400000	.80		.80	40	160 E	32.6	19.4	10.8	102	20.9	12.4	6.9
DIESEL 13	1989	13750	15625(2)	A	4000	6.90	400000	.80		.80	40	160 E	32.6	19.4	10.8	102	20.9	12.4	6.9
CC1	1991	17760	22200			13.80	13052	.80				158	15.0	12.0		71.2	6.8	5.4	

NOTES: (E) = SATURATED
(I) = UNSATURATED
(1) = REACTANCES FOR D4-D9 BASED ON 7000 KVA (5600 KW @ .8 PF)
(2) = REACTANCES FOR D10-D13 BASED ON 15625 KVA (12,500 KW @ .8 PF)
A = ATMOSPHERIC PRESSURE

GENPP 16-5
APRIL 1989
MGMGEN87.GENDATA

FIGURE 8.3G
MECO GENERATOR DATA

MAUI ELECTRIC CO., LTD - TURBINE AND ENGINE DATA - 1993

UNIT	NAMEPLATE KW (RATED/MAX)	CAPABILITY KW (INCLUDE 10% 2HR O.L. FOR DIESELS)	SPEED RPM	WR2 LB-FT2	TURBINE OR DRIVER TYPE	THROTTLE F	THROTTLE PSIG	EXHAUST HG ABS	MAKE	SERIAL NUMBER ENGINE OR TURBINE	SERIAL NUMBER GENERATOR	MFR.
KAHULUI												
UNIT 1	5000/6250	6200	3600	5,920	SINGLE	725	400	2.0	WEST.	5-A-2117-1	1S-28P820	WEST.
UNIT 2	5000/6250	6400	3600	5,920	SINGLE	725	400	2.0	WEST.	5-A-6774-1	1S-36P525	WEST.
UNIT 3	11500/12650	12400	3600	18,750	SINGLE	825	600	1.5	WEST.	10-A-4167	1S-47P458	WEST.
UNIT 4	13429	14500	3600	10,344	SINGLE	850	600	2.0	G.E.	173315	8354765	G.E.
MAALAEA												
DIESEL 1	2500	2750	900	2,360	ENGINE				G.M.		9775-1	G.M.
DIESEL 2	2500	2750	900	2,360	ENGINE				G.M.		71505-1	G.M.
DIESEL 3	2500	2750	900	2,360	ENGINE				G.M.		71506-1	G.M.
DIESEL 4	5600	6160	400	231,500	ENGINE				COOPER-BESSEMER		8373580	G.E.
DIESEL 5	5600	6160	400	231,500	ENGINE				COOPER-BESSEMER		8373581	G.E.
DIESEL 6	5600	6160	400	231,500	ENGINE				COOPER-BESSEMER		8373582	G.E.
DIESEL 7	5600	6160	400	231,500	ENGINE				COPPER-BESSEMER		8373583	G.E.
DIESEL 8	5600	6160	514	174,500	ENGINE				COLT-PIELSTICK		504543-R1	BELOIT
DIESEL 9	5600	6160	514	174,500	ENGINE				COLT-PIELSTICK		504602-R1	BELOIT
DIESEL 10	12500	13750	450	696,000	ENGINE				MITSUBISHI-MAN	D155066	S.O.1258AA-01 G.D. EC-60844-HN	WEST.
DIESEL 11	12500	13750	450	696,000	ENGINE				MITSUBISHI-MAN	D155063	S.O.1087AA-01 G.D. EC-60844-HN	WEST.
DIESEL X1	2500	2750	900	2,360	ENGINE				G.M.		71505-1	G.M.
DIESEL X2	2500	2750	900	2,360	ENGINE				G.M.		71506-1	G.M.
DIESEL 12	12500	13750	450	696,000	ENGINE				MITSUBISHI-MAN	D155066		
DIESEL 13	12500	13750	450	696,000	ENGINE				MITSUBISHI-MAN	D155063		
CC1	15000	17760	3600	10916	ENGINE							

GENPP 16-5
APRIL 1989
MGMGEN87.GENDATA

FIGURE 8.3H
MECO TURBINE DATA

MAUI ELECTRIC CO., LTD. - CUSTOMER GENERATOR DATA - 1993

MECO	DATE OF COMMERCIAL OPERATION	MAXIMUM NAMEPLATE RATING KW	KVA	SPEED RPM	RATED KV	P.F.	GEN.WR2 LB-FT2	TURB WR2 LB-FT2	GEN SCR	PER CENT ON RATED VOLTAGE NAMEPLATE KVA BASE XD	X'D	X''D	XO	RATED KV 10 MVA BASE XD	X'D	X''D	XO
HC&S CO.SYS.																	
PUUNENE																	
UNIT NO. 1	1938	4000	5000		2.4	.80	3250	8340	0.95	118	15.8	8.4	3.0	236	31.6	16.8	6.0
UNIT NO. 3	1972	10000	12500		13.8	.80	11720	8595	0.907	127	13.0	9.0	3.5				
UNIT NO. 2	1956	10000	12500		11.5	.80	11805	8724	0.907	127	13.0	9.0	3.5	102	10.4	7.2	2.0
UNIT NO. 4	1982		24500	3600	13.8	.80	17186	14598	0.58	153.6	16.9	11.5	6.9				
PAIA																	
UNIT NO. 1	1946	4000	5000		2.3	.80	3250	7779	0.95	118	15.8	8.4	3.0	236	31.6	16.8	6.0
UNIT NO. 2	8/1960	4000	5000		2.3	.80	3200	6363	0.885	137	19.1	9.0	4.5		38.2	16.8	
PAIA HYDRO																	
UNIT NO. 1	PRE WAR	800	1000		2.4	.80	(1)			86.7	22.2	14.8	20.0	867	222	148	200
KAHEKA																	
UNIT NO. 1	PRE WAR	1333	1667		2.3	.80	(2)		(3)	123	28.8	19.2	24.6	738	173	115	148
UNIT NO. 2	PRE WAR	1333	1667		2.3	.80	(2)		(3)	123	28.8	19.2	24.6	738	173	115	148
UNIT NO. 3	PRE WAR	1333	1667		2.3	.80	(2)			123	28.8	19.2	24.6	738	173	115	148
PIONEER MILL																	
UNIT NO. 1	1966	6250	7812		12.5	.80	6264	7714	0.84	138	14.5	10.5	3.3	147	15.5	11.2	3.5
UNIT NO. 3	PRE WAR	3000	3750		12.0	.80				110	15.0	9.0	3.0				
UNIT NO. 4	PRE WAR	3000	3750		2.3	.80	3240	4799	1.14	105	8.5	7.0	0.6	280	22.7	18.7	1.6

NOTES: (1) H = 1.79, TO INCLUDE WATER WHEEL INERTIA ADD 25% TO GENERATOR INERTIA.
(2) H = 0.676, TO INCLUDE WATER WHEEL INERTIA ADD 25% TO GENERATOR INERTIA.
(3) 1.12-1.18

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FIGURE 8.3I
MECO CUSTOMER
DATA

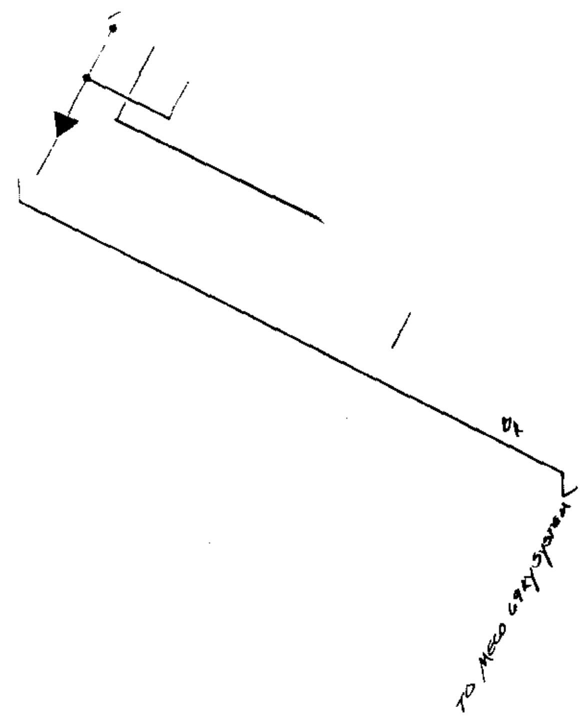

FIGURE 8.3J
PRELIMINARY MAALEA
SINGLE LINE DIAGRAM

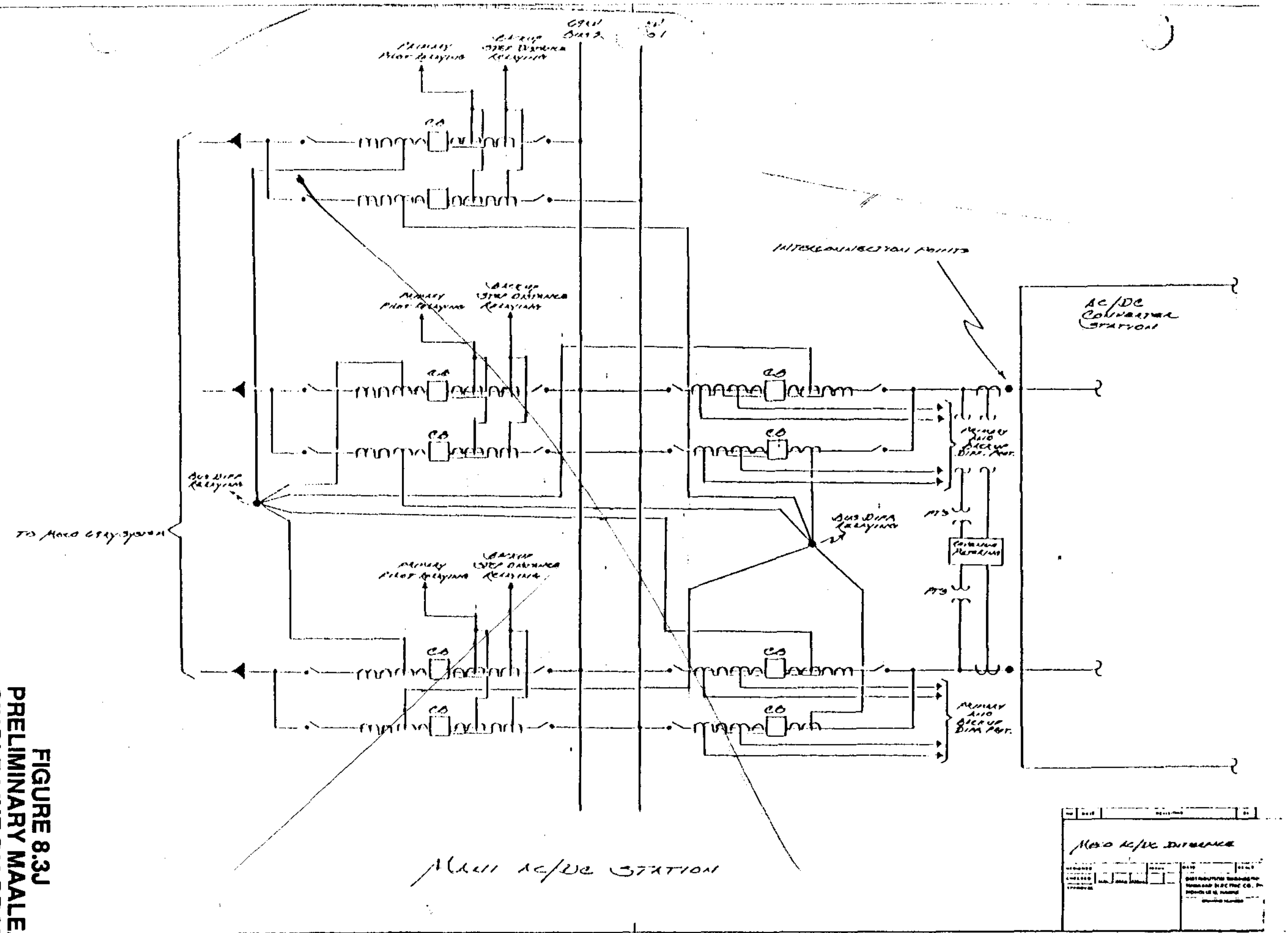

FIGURE 8.3J
PRELIMINARY MAALEA
SINGLE LINE DIAGRAM

APPENDIX A

GEOTHERMAL RESOURCES
OF THE
KILAUEA EAST RIFT ZONE

Prepared from Public Records
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APPENDIX A

GEOTHERMAL RESOURCES OF THE KILAUEA EAST RIFT ZONE

A.1 HAWAIIAN ISLANDS - ORIGIN AND ACTIVITY

The island of Hawaii is the newest member of a chain of volcanoes that have repeatedly matured as major islands in the middle of the northern Pacific Ocean. An obscure complex of processes is generating inordinate quantities of magma in a deep earth phenomena, the mantle plume or mantle hot spot. Within the plume, at depths of 60 kilometers and more, the Hawaiian basaltic magma (tholeiite) forms at temperatures of 1350 to 1400°C. These high temperatures impart an extreme fluidity and density reduction to the magma. The upward mass movement of magma easily penetrates the relatively thin oceanic crustal plate and rapidly constructs new volcanoes on the deep ocean floor (Decker, 1987).

The Hawaiian mantle hot spot, fixed in position and operating as an energy and mass transfer system for more than 70 million years, is undeterred by the steady northwestward movement of the Pacific crustal plate above it. This plate movement has preserved a trail of older volcanoes and seamounts, The Hawaiian-Emperor Volcanic Chain, which courses straight and west-northwest for 3550 kilometers. After a 60° right bend, the chain holds a straight, north-northwest course for an additional 2600 kilometers before its destruction, with the Pacific crustal plate, by subduction in the Aleutian Trench. The 3550 kilometer distance between currently active volcanic centers (southeastern island of Hawaii) and the bend represents 44 million years (my) of relatively continuous and increasing magma production by the Hawaiian hot spot. The volcanic rock produced, an approximate volume of 750,000 cubic kilometers, now stands on the seafloor as the long, linear Hawaiian Ridge. The potassium-argon age dates of lava rocks in the State of Hawaii range from 5.7 to 5.4 my, respectively, on Nihau and Kauai, to 0.375 - 0.4 my at Mauna Kea and Mauna Loa, the giant shield volcanoes on Hawaii. Volcanic growth studies indicate that the Hawaiian hot spot is presently generating lava volumes at the greatest eruptive rates in its known history (Clague & Dalrymple, 1987).

The island of Hawaii is one of the largest volcanic mountains on the earth. It is a composite structure of five volcanic centers including the two mighty shield volcanoes Mauna Kea and Mauna Loa. Often snow covered, these two young peaks stand nearly 4200 meters above sea level and nearly 9700 meters above the ocean floor in the Hawaiian Trough, a submarine basin northeast of the island. The island's land area of 10,438 square kilometers has maximum dimensions of 150 kilometers N-S and 129 kilometers W-E. Only 11 percent of the total volcanic rock mass rises above sea level. Initial lava eruptions on the ocean floor constructed volcanic seamounts, probably first broaching sequentially as separate islands, then rapidly coalescing to form the large, young, present island of Hawaii.

The five volcanic centers on the island of Hawaii, in sequence of diminishing age, are Kohala, Mauna Kea, Hualalai, Mauna Loa and Kilauea. The southeastward trends of increasing youth, volcanic activity and seismicity are even more evident with the inclusion of the active volcanic seamount, Loihi, 50 kilometers south of Kilauea's summit caldera with its summit 970 meters below sea level (see Figure A-1 and Malahoff, 1987). Table A-1 presents key information on the ages and sequence of volcanic activity at these six centers.

The magma and lava processes, now operating in their upper dynamic ranges at Kilauea, repeat the distinctive, comprehensible style of Hawaiian volcanism. Compared to the worldwide explosive volcanic events common to both geologic and human history, Hawaiian volcanism is reasonably well mannered and approachable. This was implicit in the action of Thomas A. Jagger, (1871-1953) a Massachusetts Institute of Technology professor, who established in 1912 the initial scientific facility that was to become the Hawaiian Volcano Observatory (HVO), at the summit of Kilauea. HVO has gathered and interpreted an extraordinary body of knowledge about the mobile magmas and lava that continue to build Kilauea and the Hawaiian volcanic chain in the mid Pacific. The U.S. Geological Survey (USGS), having staffed HVO since 1947, has led this scientific achievement. In 1987, marking the 75th anniversary of HVO, the USGS published a large, two volume compendium entitled Volcanism in Hawaii, Professional Paper 1350 (Decker, et al., 1987). There was no intent to examine the geothermal energy potential of Kilauea amidst the many scientific objectives of this excellent collection of papers. However, the papers in Professional Paper 1350 are important supplements to a thin geothermal drilling and production data base for any evaluation of the geothermal resource which exists in the East Rift Zone of Kilauea. (Professional Paper 1350 may be examined or purchased at the Earth Science Information Center, USGS, 504 Custom House, 555 Battery Street, San Francisco, CA 94111. Telephone 415-556-5627.

The vertical magma conduit under the summit of the Kilauea volcano is the central feature of a vigorous construction process. A catalog of 70,000 earthquakes, collected by HVO since 1962, reveals in substantial detail the active processes of magma transport within Kilauea's structures (Klein, et al., 1987). Long period earthquakes trace both conduits and magma bodies rising from 60 kilometers depths to a shallow magma reservoir between 3 and 7 kilometers below the summit caldera floor. The reservoir is aseismic because it stores a relatively large mass of hot liquid charges of rising magma until an eruptive event is initiated at the summit or the magma moves laterally into linear rift zones for further underground distribution. The openings into Kilauea's two active rift zones are near the upper limit of its summit magma reservoir. The solid roof of both the reservoir and the lateral conduits show varying levels of seismicity which reflects magma mass and transport at greater depth. The long linear rift zones, radiating from the summit reservoir, effect a fundamental, horizontal, internal distribution of magma away from a volcanic center. A tensional stress field, across the rift zone, facilitates magma emplacement commonly driven downrift by the hydrostatic head gained from its brief residence in the summit reservoir.

The Hawaiian volcanic rift zones are created as the roofs and surface expression of active deep magma conduits. Both transient and locally stored magma masses establish an abundance of thermal energy. Specifically, it is the repetitive process of magma emplacement as near vertical dikes in the tensioned roof rock which creates the heat source for a geothermal resource potential in an active rift zone. The Kilauea East Rift Zone (KERZ) is in a vigorous stage of growth with a geologically optimal level of internal magma activity. It is flanked by an abundant groundwater regime on the north and by the sea on the south. The junction of abundant heat and fluids along the KERZ establishes its unique geothermal resource potential.

A.2 KILAUEA EAST RIFT ZONE AND ITS GEOTHERMAL RESOURCE POTENTIAL

The topographic form of the KERZ, after its gradual emergence from Kilauea's gentle summit rise, is that of a broad, linear ridge. The ridge crest courses east-northeast and straight for 42 kilometers, from an elevation of 880 meters at Makaopuhi Crater to sea level at Cape Kumukahi (see Figure A-2). Beyond the Cape, the submarine element of the KERZ carries the same straight course for an additional 70 kilometers to termination on the ocean floor at an approximate depth of 4,800 meters. The entire structure, subaerial and submarine, was built rapidly by repeated rift crest lava eruptions supplied by magma transport in the underlying conduit. In the middle of the subaerial element the lava apron has a maximum topographic width of 18 kilometers measured normal to the rift axis. The more significant feature of the KERZ is the crestal band of local volcanic cones, craters, linear fissures and graben fault structures that reflect the crestal, cross rift, tensional stress above the deep magma conduit. The surface width of this active band is approximately 3 kilometers.

In 1976, at a location approximately 10.5 kilometers uprift from Cape Kumukahi and on the active crest of the KERZ, the initial geothermal test well, HGP-A, was drilled to a total depth of 1966 meters. A bottom hole temperature of 358°C was encountered and a total mass flow rate of 110,000 pounds per hour, 43 percent steam and 57 percent liquid, was measured. Following installation of a 3 MW turbine generator in March 1982, the steam production of this initial well has provided electric power in the range of 2.8 to 2 MW. Except for scheduled overhauls, this small geothermal power plant has operated continuously for seven years with an availability factor of approximately 90 percent. The geothermal fluid and electrical production from this single well and plant, now called the HGP-A Generator Facility, is discussed in more detail in Section A.5. This achievement provides the most meaningful indication of an exploitable geothermal resource in the KERZ.

The internal fabric of fast-building Hawaiian rift zones is a nearly horizontal, planar sequence of submarine and subaerial lava flows. These basaltic flows originate from local volcanic vents or parallel linear fissures situated along the rift crest overlying the deep magma conduit. In the upper part of the KERZ the top of the magma conduit appears to be shallower (seismicity to 2-3 kilometers) and consistently open (deeper aseismic zone) as discussed in Hardee, 1987. The continuous lava eruption which began in January 1983 in the upper KERZ, is now venting from a at their full risk in evaluating and responding to the status of lands and leases in the KERZ.

Off-road accessibility in most of the KERZ terrain is difficult to impossible, even for four wheel drive vehicles. Dense undergrowth, forest cover and impassable lava rock surfaces are typical barriers. Most private land tracts are fenced or posted against trespassing. New road construction approvals for geothermal development will be keyed to the status of the land traversed: agricultural, rural or conservation.

A.5 ELECTRIC GENERATION AND RESOURCE PRODUCTION IN THE KERZ

The 3 MW power plant of the HGP-A Generator Facility was constructed in 1981 with funds jointly provided by the U.S. Department of Energy, the State and the County of Hawaii. A profile of the plant's electric generation history is shown in Figure A-7 for the seven year interval, commencing in March 1982, of commercial power delivery to Hawaii Electric Light Company. Because of economic constraints, detailed well production records were not accumulated. Possible declines in wellbore deliverability or reservoir performance might be inferred from generator outputs; an initial peak output of 2.8 MW versus 2.45 MW currently suggest a 1.8 percent annual decline in well production. Although several scheduled overhauls were made without finding serious degradation, certain material and equipment deficiencies in plant design have been clearly demonstrated and may be registered in the output decline. Cumulative silica scaling in the HGP-A wellbore may be a contributing cause of the apparent decline. Several very informative studies of plant and well performance have been completed and documented in recent years by Donald Thomas of the Hawaii Insitute of Geophysics.

The continuous 7-year geothermal fluid production of the HGP-A well has been very successfully utilized. However, it has afforded only a meager basis for understanding the geothermal resource. The lack of detailed records of fluid production parameters, of periodic pressure-temperature-spinner surveys over the well's 3530-foot perforated liner completion interval and of reservoir pressure monitoring in any offset observation hole are to be noted. This provides little context within which several perceptive and thorough studies of produced fluids chemistry can be conclusively judged (Thomas 1985a and 1987).

The total mass flow of HGP-A well, measured initially as approximately 47,300 pounds per hour steam and 62,700 pounds per hour liquid, is a product of wellbore mixing (inside 7 inch production casing) of different fluids from multiple, separate entry points of imprecise depths, pressures and temperatures. The distinctive, low salinity of the first produced liquid, suggestive of a meteoric water dominance in the geothermal reservoir, was lost in a gradual, four-year increase in salinity, to about 15,000 mg/kg of NaCl, with production for electric generation. The Na and Cl ionic ratios and other metallic changes seem to prove a seawater intrusion into HGP-A well's production sink. This fluid change to a new high but stable, level of salinity appears to confirm the implications of an irregular presence of anhydrite filled fractures amidst other alteration minerals found in the HGP-A rock cores from the reservoir interval. Fracture guided intrusions of seawater into the geothermal fluid convection cells must repeatedly occur. However, these intrusions individually are probably limited in duration and volume because of rapid self-sealing by new mineral deposition at the seawater-geothermal fluid interface. A diminution of pH from 7.6 to 6.5, attending the increase in salinity of produced brines, was measured. Possible minor decreases in produced steam fraction and wellhead temperature, if suspected from time to time in short term flow variations, have not been measured to identify any long term trend. The precisely identified stability of the silica content of the brine (about 800 mg/kg) and of the low content of non-condensible gas (0.3 percent by weight) in the steam phase reflect the apparent stability of the total mass flow produced by the HGP-A well since December 1981.

Key information from the seven deep geothermal wells drilled into the geothermal reservoir, or equivalent depths, in the lower KERZ is summarized in Table A-2. Their locations are shown on Figure A-6.

Key features of the wells which penetrated the geothermal reservoir were 9 5/8 inch production casing (cemented just below 4000-feet in KS wells) and 7 inch perforated liner in an 8 1/2 inch hole to total depth. It should be noted that both HGP-A and KS-1 wells include remedial 7 inch casing inserts that were emplaced before production and testing. The KS 1 and 2 tests support the recent conclusion (Thomas, 1987) that a dry steam producing zone exists in the HGP-A well. Composite chemical data from the four wells tested are presented in Tables A-3 and A-4.

Final Hawaii County approvals are being sought for the Geothermal Resource Permit for the PGV's proposed 25 MW (net) geothermal plant and wellfield which expectedly will include KS-1A and 2 wells in production service. Drilling plans for the required additional production and injection well are in preparation for a commencement of development operations later in 1989.

A proposed Scientific Observation Hole Program at additional locations within the GRS areas along the lower KERZ is planned. The intended slim hole drilling program, utilizing both rotary and diamond core procedures, is jointly funded by the State of Hawaii and geothermal operators (Geothermal Resources Council Bulletin, 1988). Information from the intended 4000-foot holes is to be promptly released to the public domain and should be available during the negotiation period for the Power Purchase Agreement.

A.6 GEOTHERMAL RESERVOIR POTENTIAL IN THE KERZ

The geothermal reservoir potential of the KERZ is most strongly supported by the HGP-A Generator Facility performance combined with its position above a magma conduit which is reasonably defined as to location and function. The critical concern is an estimate of the magnitude of this reservoir potential within the lower KERZ between the C48 vent and Cape Kumakahi (30 kilometers or 18.6 miles).

Volcanic eruptive history proves recurring magma transport through the entire lower KERZ. Significant lava eruptions from Heiheiahulu "in the reign of Arapai" - circa 1750 A.D. (vent is 22 kilometers SW of Cape Kumakahi) and the Kapoho eruptions of 1955 and 1960 obtain importance against a detailed modern study of Kilauea's magma balance. The USGS - HVO concludes that nearly 50 percent of all magma mass remains below ground, being emplaced as intrusive dikes and sills. The entire KERZ has become a more favored structure for magma distribution and dike construction since the magnitude 7.2 Kalapana earthquake of 1975 which tensionally opened the entire KERZ structure by seaward slumping of its south flank, as shown in Figure A-8 and discussed by Lipman, et al., 1987. A preliminary estimate, made from deflations of Kilauea's summit following the 1975 quake, was that 3 million cubic meters per month of magma was moving into the rift zones. The deep fracturing in the KERZ consequent to this major earthquake should enlarge or maintain reservoir permeability and new meteoric and seawater inputs to geothermal fluid convection cells. Heat, fractures and fluids are renewed in the dynamic, continuous structure above the KERZ magma conduit.

The 500 MW objective of this RFP is based on market considerations (Lesperance, 1988, and Department of Business and Economic Development, 1989). No integrated study exists of all the KERZ geoscientific and well data that would provide a creditable estimate of the total geothermal potential. Only additional drilling, flow testing and production can provide measures of the energy capacity that is indicated to exist in the GRS of the KERZ. It is of some interest to note that one existing developer intends to utilize a 500 acre land area dedicated to its 25 MW (net) generation capacity. This suggests that the 22,000 acres within the three GRS areas, if only 50 percent productive, could yield 550 MW of capacity.

A.7 GASEOUS AND LIQUID WASTE DISPOSAL FROM GEOTHERMAL WELLFIELD ACTIVITIES

Effluent waste disposal from the producing HGP-A well has not been managed in a way that is acceptable for future geothermal development in the KERZ. The 57 percent brine fraction, carrying about 15,000 mg/kg of NaCl and 800 mg/kg of SiO_2, is discharged to shallow surface ponds for percolation into the ground. The attending silica deposition eventually precludes percolation and new ponded areas are then utilized. This practice is unacceptable for the future commercial development that will occur along the KERZ. The produced non-condensible gas (NCG) is burdened with about 850 mg/kg of H_2S. Normal plant operation produces 1100 pounds per day of H_2S that is now abated, with reasonable reliability, with NaOH in a two stage scrubber and by incineration. The H_2S abatement experience at HGP-A, although costly and problem-plagued, provides notice that reliability, reserve capacity and alternate options of H_2S mitigation will be essential to successful "good neighbor" geothermal development in the KERZ. It is appropriate to note that PGV's Amended Application for Geothermal Resources Permit for 25 MW (net) Plant and Wellfield (December 1988 submittal to Hawaii County Planning Department) proposes the injection of recombined streams of brine, condensate and NCG back into the geothermal reservoir. Just such recombined fluid injection reportedly is successful in its first year of utilization in the Coso geothermal field in California.

The present status of H_2S emission controls, regarding geothermal development in the KERZ, merits special attention. A 1982-1983 State survey of H_2S levels in a 27 station KERZ grid was completed, as were local surveys by HGP-A and PGV. These surveys should provide some insight into natural H_2S emissions from continuous volcanic gas venting that proceeds between the obvious eruptive events. Aside from this singular feature of the KERZ, the Hawaii Department of Health (DOH), as the State regulatory authority, is now proposing a statewide ambient 1-hour emission standard of 139 micrograms H_2S per cubic meter (0.1 ppmv) for inclusion in Administrative Rules Chapter 11-59. DOH also proposes a statewide allowable increment of 0.35 mg/m^3 (0.35 ppmv) of H_2S emission from any new facility. This proposal and lesser H_2S constraints are included in draft DOH Rules 11-60-15 and 16.

An additional DOH regulatory authority extends statewide to underground injection control (UIC). Though the non-potable quality of ground water was proven by landowner drilling in the KERZ before recognition of the geothermal resource, some of the GRS areas remain in the Underground Sources of Drinking Water (USDW) status. Injection of produced geothermal fluids will require approval by the DOH.

A.8 VOLCANIC AND SEISMIC IMPACTS ON WELLFIELD DEVELOPMENT

An excellent summary of the volcanic hazards that occur along the KERZ is presented by Mullineaux, et al. 1987. Lava flows will pose the most likely hazard over time, as shown in Figure A-9. However, lava flows are controlled by topography, as any surface water flow would be. A careful evaluation of the KERZ terrain can be made with the assistance of detailed topographic maps recently published by the USGS (1:24,000 scale and 20-foot contour interval). The probable flow course and other possible topographic controls can be reasonably predicted. The morphology and emplacement dynamics of the blocky aa type of lava flow are detailed by Lipman and Banks, 1987. This more viscous, thicker building flow commonly moves in a 100-200 meter frontal width, several meters high and at velocities up to 50 meters per hour. Final flow thickness may range from 5 to 10 meters in height.

The less likely but more serious volcanic hazard, the fissure or vent eruption site event, is mitigated by the much smaller area of direct impact. However, against the expected long life of the geothermal resource it cannot be considered predictable in time or location. It will remain the greatest risk in development of the geothermal resources of the KERZ. Air lofted tephra (rock debris) ash and gas concentrations from eruptions may yield a range of secondary and addressable impacts on any KERZ geothermal site depending on wind conditions and distance from source points. Ground surface dilation, extension or subsidence due to local magma movements or lava discharges, are additional processes common in the KERZ that are of minor impact on wellfield operations.

The high seismicity of the KERZ is directly correlated with its high level of constructional volcanic activity. This is clearly presented in an excellent new map publication of statewide scope: "Seismicity of Hawaii, 1962-1985, USGS Open File Report 88-285" which may be purchased at the Pacific Map Center, 647 Auahi Street, Honolulu, HI 96813, Telephone 808-531-3800. The seismicity of Kilauea's magma system, detailed by Klein, et al., 1987, chiefly includes events of less than magnitude 4 which are generated by magma and dike activity in the 2-5 kilometers depth interval. This class of seismicity presents a significant guide for geothermal wellfield development and presents little or no attendant hazards. It is the deep, infrequent, tectonic earthquakes of magnitudes ± 7 which could impact KERZ geothermal development. Fortunately, the largest historical earthquake in this class, the November 1975 magnitude 7.2 event, at a depth of 9 kilometers under Kalapana on the southeast coast of the Island of

Hawaii, was fully recorded by the HVO seismic network. This imposed a 0.22 gravity acceleration measured at Hilo (43 kilometers NNW of Kalapana). Geothermal wells in the KERZ, with multiple cemented casing strings and Series 900 wellheads, spider braced in reinforced concrete cellars, should surpass the 0.4 gravity acceleration factor selected for the plant and surface facility design to safely withstand the tectonic class of earthquake.

Significant strategies can be utilized for the protection of KERZ geothermal wellfield development and production operations. Directional drilling would permit wellheads to be clustered on elevated or cinder berm protected wellpads that would be at minimal risk from both volcanic and the seismic hazards. Drilling rigs may merit heavier guy-lines as added protection. Steam and other wellfield pipelines will be vulnerable to lava flows and to major earthquakes. Rapid cinder berm construction and pipeline repair capacities can be considered as response options.

The common volcanic-seismic basis of both the resource and hazards in the KERZ should encourage development of key surveillance methods. A very sensitive seismic net could simultaneously forecast possible lava eruptions and track the wellfield production and injection fluid impacts to optimize geothermal reservoir management. Multiple physical and chemical parameters can be examined for volcanic-seismic-exploitation correlations that may increase thermal energy recovery and reduce the attendent risks.

A.9 GEOTHERMAL WELLS AND WELLFIELD CONCEPTS AND OPTIONS

The important tasks in future geothermal drilling in the KERZ will be to increase well productivity and reduce well costs. An early evaluation of directed, angled completion intervals seems appropriate, given the common feature of near vertical and planar fractures, partings and dikes parallel to the rift axis, in the expected production intervals. The four penetrations of the fluid yielding reservoir to date were in vertical wellbores, which is less than an optimal orientation to intercept near vertical openings. If an upper reservoir yield of 100 percent steam production could be achieved by more precise completions, possibly in the 4000 to 6000 foot depth interval as suggested in the KS wells, a productivity increase and associated cost reduction might significantly assist initial wellfield development. This finding would next invite consideration of "big hole" production wells.

In the context of improving well productivity and accurately measuring the results, it is important to note that initial well flow testing of KERZ geothermal wells is not a simple and low cost task (D'Olier and Iovenitti, 1984). The presence of cool groundwater aquifers to possible depths of about 2000 feet calls for gradual preparations. An initial static warmup (first geothermal fluids rising within the completion fluid column of the shut-in well) followed by accelerated heating and deliberate bleeding will elevate the wellbore to a more uniform thermal state to accommodate the initial high mass - high temperature flow upon opening. The capacity to go promptly to fully opened, vertically vented flow to atmosphere must be present because of an extremely erosive initial discharge of a sharp grit of rock and minerals from the producing formation. A continuous, full open flow, with its 120 decibel noise penalty, appears to be the most efficient, fast and safe procedure to obtain this critical well cleanup before shunting the flow into measurement runs and muffled venting.

As waste fluid injection is thoroughly evaluated and is considered for high utilization in the KERZ, the function and reliability of injection wells will become as critical to system operations as production wells are. Expecting a design and quality comparable to production wells, injectors must be further protected with a hang down casing string (replaceable) as the injectate conduit to the perforated linered interval at depth. Actually, marginal production wells may be placed on back up injection service with the addition of a protective hang down string. It appears that accurate and detailed knowledge of geothermal reservoir performance and optimal utilization of every well will be essential in the KERZ.

A.10 MATURITY OF TECHNOLOGY

The improvement of geothermal well design and material selection will be important considerations for economic development of KERZ reservoirs. The conventional design and K-55 grade of casing and liner used in the HGP-A well seems to be endorsed by more than seven years of continuous production. However, the down hole conditions of this wellbore are poorly known. The costs of the offset wells, at industry market rates in the early 1980's, commonly exceeded $2,000,000 per well for drilling and completion. Substantial improvements in logistics and management of future development drilling should be important cost reduction factors. Upgrades in tubular materials, couplings, and possible cementing in tension procedures may provide gains on a benefit-to-cost basis. Modern rotary drilling, cementing and drilling fluid practices are mature practices that should serve efficiently in KERZ geothermal wellfields. ANSI 900 series wellhead equipment is indicated for standard utilization on KERZ production wells.

The production of two-phase fluid production and 100 percent steam production are mature geothermal industry technologies. High volume liquid injection into a producing geothermal reservoir is a developing technology in the industry. Injection into KERZ reservoirs may prove difficult to integrate with the production objectives; an alternate injection disposal target may be deep seawater zones immediately south of the expected geothermal reservoirs.

The substantial daily fluctuation of the Oahu power requirements indicates that PROPOSERS should consider a load-following, daily cycling of KERZ geothermal wellfield production as one option among other possible responses. Daily cycling in the form of a shared reduction of steam supply, from a wellfield sector producing commonly to one generating plant, is not known to be a sustained practice anywhere in the geothermal industry at this time. The required reduction alternatively might be achieved by a nightly shut-in of a much smaller number of wells. The impacts of a common nightly reduction, or of a selected (or rotated) full shut-in, will relate to the magnitude of pressure and temperature increases imposed in each wellbore, wellhead and flow control valve and to the endurance or quality of well design, materials and equipment. All of these factors will be site specific to the geothermal reservoirs, producing wells and economics to be encountered in the KERZ.

A.11 OPERATIONS AND MAINTENANCE

Replacement (makeup) well drilling, redrilling for extended or improved production or injection service, and remedial cleanouts may become significant requirements in KERZ geothermal fields. No other extraordinary requirements are indicated.

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Thomas, D.M., 1987, A Geochemical Model of the Kilauea East Rift Zone, in U.S. Geological Survey Professional Paper 1350, p. 1507.

Thomas, D.M. and Olson, H.J., 1989, Current Status and Future Research Objectives for the HGP-A Generator Facility, in Proceedings, Fourteenth Workshop, Geothermal Reservoir Engineering, Stanford University, January, 1989 (in press).

TABLE A-1
ISLAND OF HAWAII VOLCANIC CENTERS

Volcano	Oldest Lava or Flow Dates* (years age)	Eruptions	Seismicity
Kohala	700,000 K-Ar max	Last event 60,000 years ago	Minimal
Mauna Kea	375,000 K-Ar max	Last event 4500 years ago	Minimal
Hualalai	106,000 K-Ar max	1800 A.D.	Minimal
Mauna Loa	400,000 K-Ar max 38,000 C14 max	37 events 1832-1984	Occasional
Kileaua	23,000 C14 max	64 events 1790-1989 continuous since 1983	High
Loihi	Fresh tholeiite flows at summit, Age?	Per swarm?	Shallow swarms 1971-75-84

*K-Ar Potassium-Argon dating
C14 Radiocarbon dating

TABLE A-2
KERZ DEEP GEOTHERMAL WELLS

Well	Total Depth (feet)	BHT* (°F)	Comments
Ashida 1	8300	619	No permeability or fluids; suspended
HGP-A	6450	676	Producing ±110,000 lbs/hr TMF since Dec 81; about 43 percent steam and 57 percent brine
Kapoho State 1	7290	642	Short test; 72,000 lbs/hr steam;** suspended
Kapoho State 2	8005	648	Short test; 33,000 lbs/hr steam;** suspended
Kapoho State 1A	6562	572	Tested; data proprietary; shut in
Lanipuna 1	8389	685+	Low perm., trace of fluids; abandoned
Lanipuna 1 redrill	6299	300	379°F maximum; no fluids; abandoned
Lanipuna 6	4956	250+	Major L.C. zone below 4285' suspended

*Bottom hole temperature   Table modified from Thomas, 1987
**see Iovenitti and D'Olier, 1985

Well locations are shown on Figure A-6

TABLE A-3 GEOTHERMAL FLUID CHEMICAL COMPOSITION COMPOSITE DATA[a]

Element	Brine[b] (ppm(w))	Steam Condensate[b] (ppm(w))
Na	600 - 10,000	0.17
K	123 - 2,700	0.10
Ca	40 - 920	0.10
Mg	1 - 2	<0.1
Fe	<1 - 8.4	0.05
Mn	<1 - 8.5	--
B	4 - 11	<0.05
Br	40 - 80	--
I	<20	--
F	0.2 - 0.9	--
Li	1 - 9	<0.01
Cl	925 - 21,000	<2
NH_3	<0.01 - 0.1	0.12
SO_4 (c)	9.2 - 24	13
Hg	<0.001 - <0.05	--
As	0.09 - 0.4	<0.01
S= (d)	5 - 100	--
Total Alkalinity	<10	<10
HCO_3	0 - 18	0
CO_3	0	0
SiO_3	420 - 1,500	0.7
TSS	70	--
TDS (e)	2,500 - 35,000	15
pH	<5 - 5.5	3.5
Conductivity (mho/cm)	3,100 - 67,000	120
Density	1.03	--

a Composite data from three wells on the PGV site (KS-1, KS-1A, and KS-2) and the HGP-A well.

b Wellhead pressure (WHP) = 155 psig; Wellhead Temperature (WHT) = 368°F.

c Concentration high due to oxidation of S= to SO_4.

d Concentration low due to oxidation of S= to SO_4.

e TDS = Total Dissolved Solids.

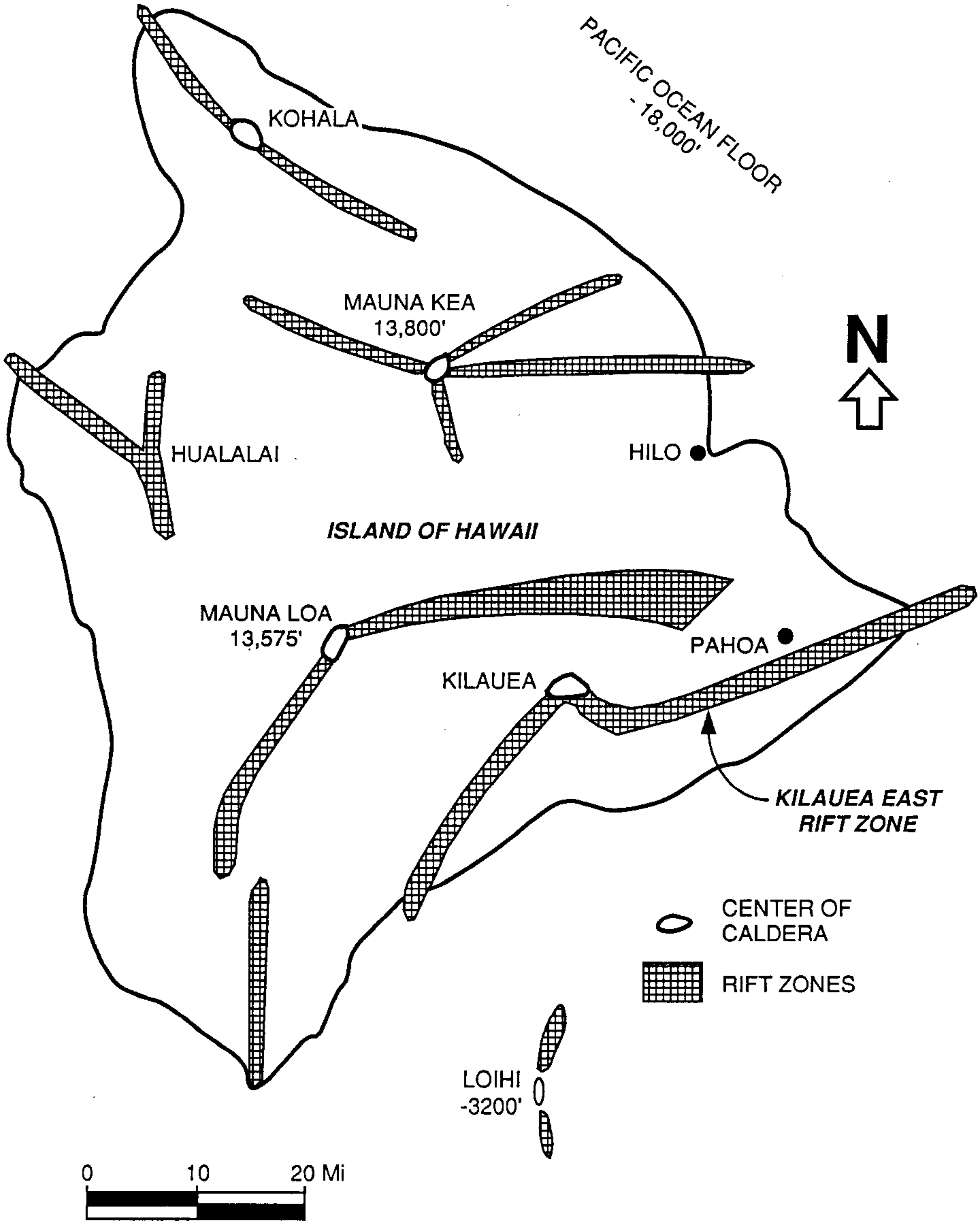
(from Department of Business and Economic Development, 1989)

Table A-4 NONCONDENSABLE GAS COMPOSITION COMPOSITE DATA[a]

Gas	Observed Steam Content ppm(w)	Plant Design Composition ppm(w)
CO_2	250 - 1,042	956
H_2S	800 - 1,300	1950
NH_3	(c)	-
Ar	6 - 13	-
N_2	10 - 700	582
CH_4	(d)	-
He	<0.009	-
H_2	11 - 140	12
Total NCG	1,500 - 2,200	3500

[a] Composite data from three wells on the PGV site (KS-1, KS-1A, and KS-2) and the HGP-A well.
[b] WHP = 155 psig; WHT = 368°F.
[c] Below Detection Limit (<1.5 ppm NH_3 in KS-1A).
[d] Below Detection Limit (<0.2 ppm CH_4 in KS-1A).

(from Department of Business and Economic Development, 1989)



M0489010

Figure A - 1
VOLCANIC CENTERS AND RIFT ZONES

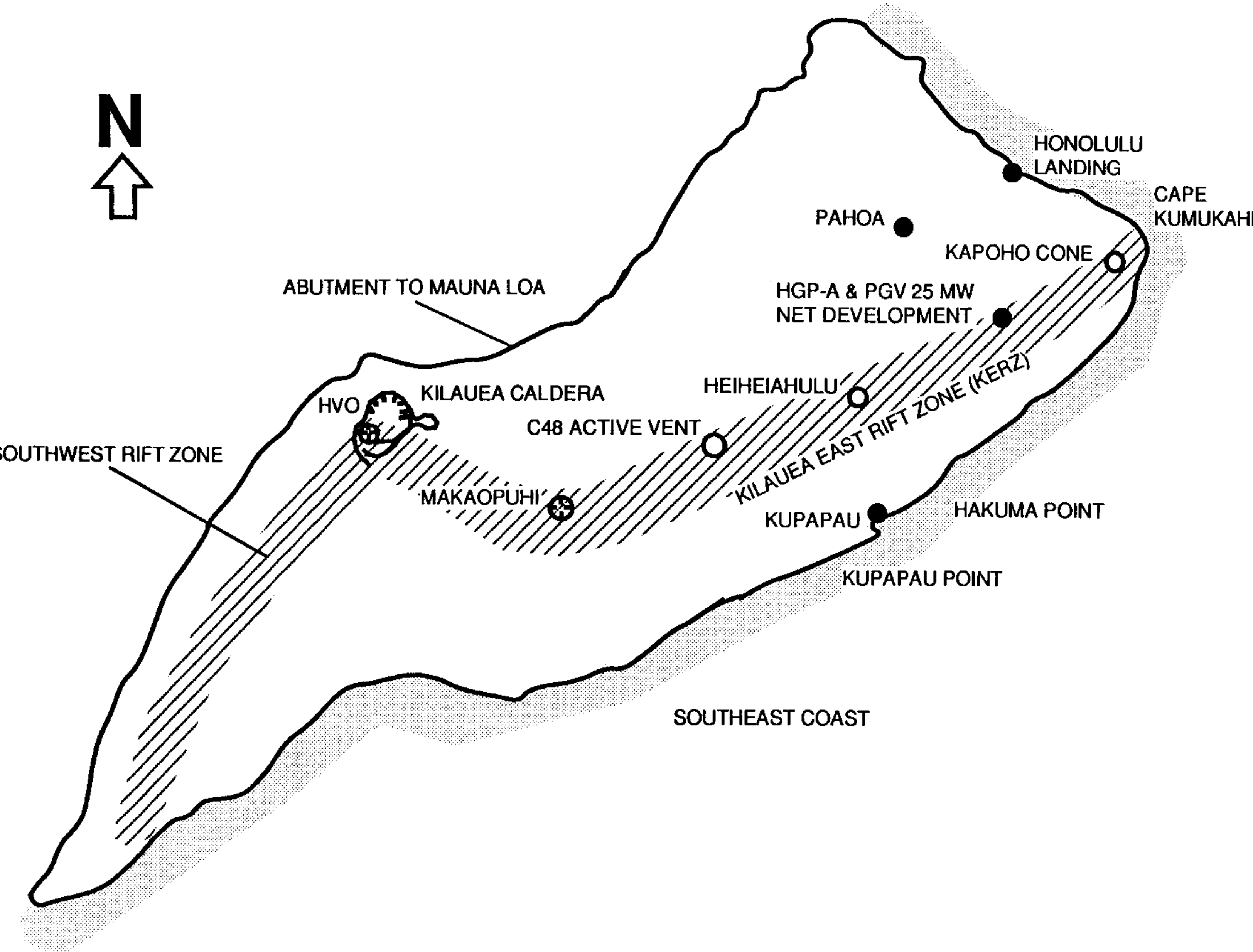


Figure A - 2
KILAUEA VOLCANO AND RIFT ZONES

M0489083

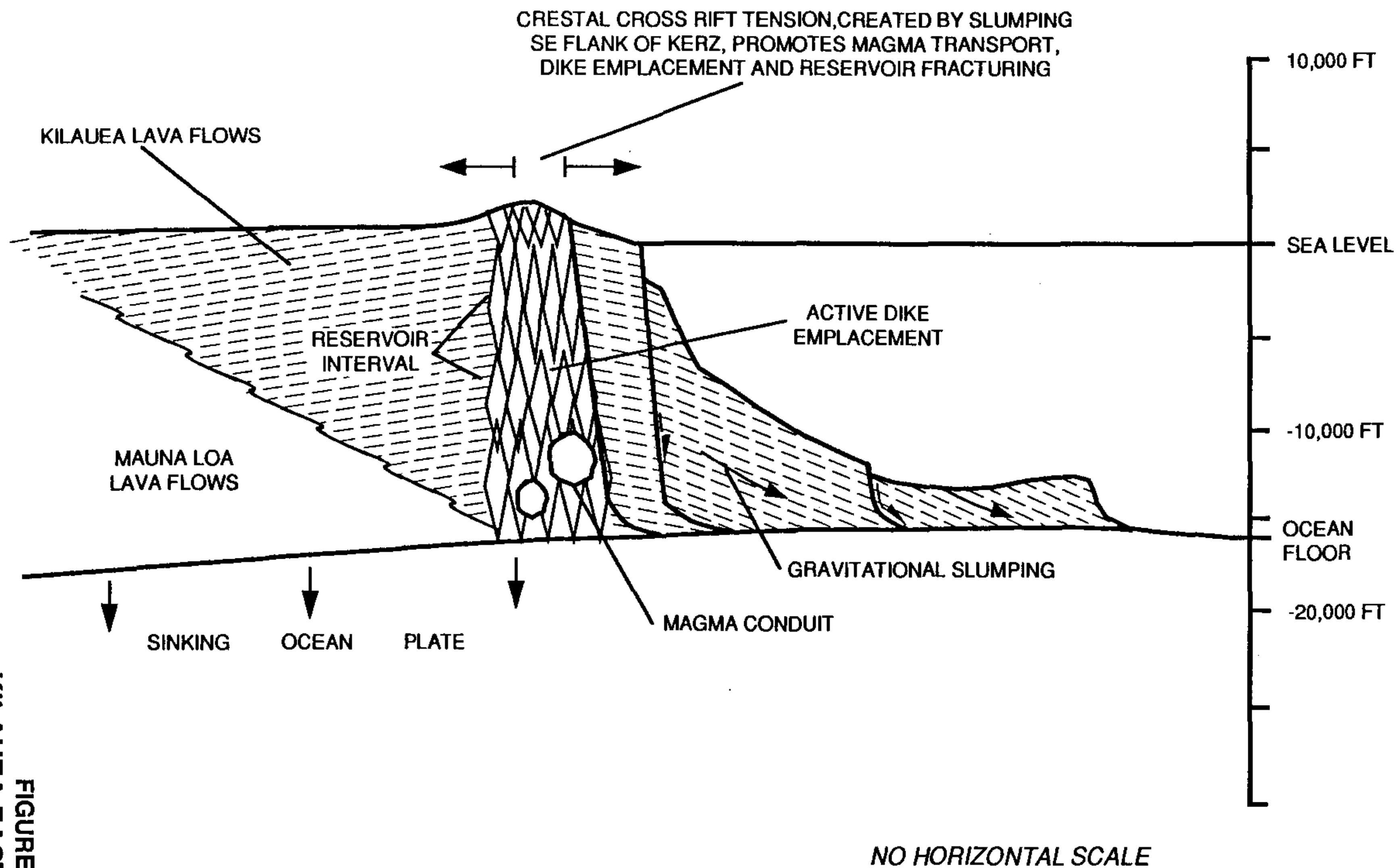


FIGURE A - 3
KILAUEA EAST RIFT ZONE
CROSS-SECTION

M0489007

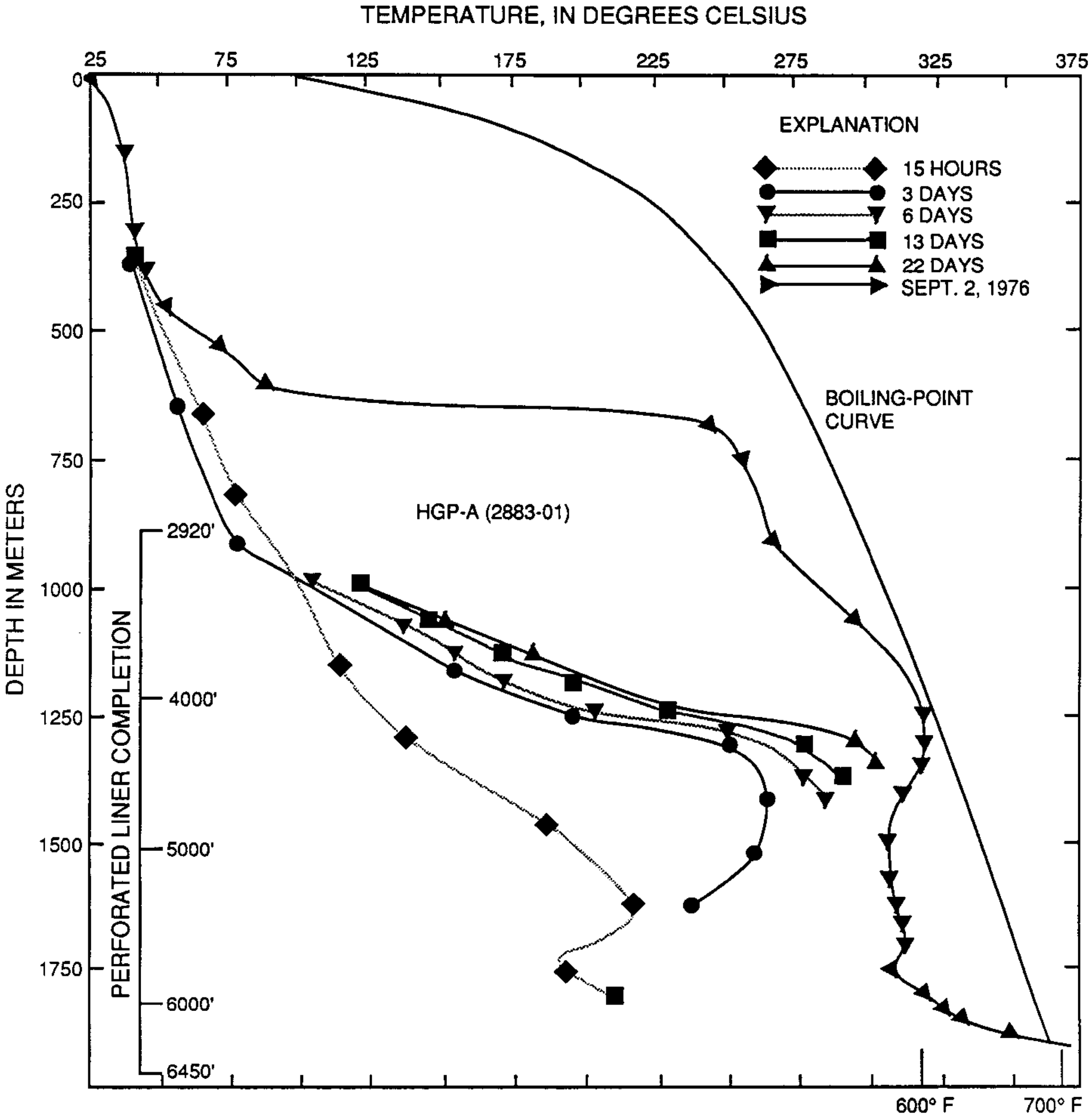


Figure A - 4
HGP-A WELL TEMPERATURES

M0489013

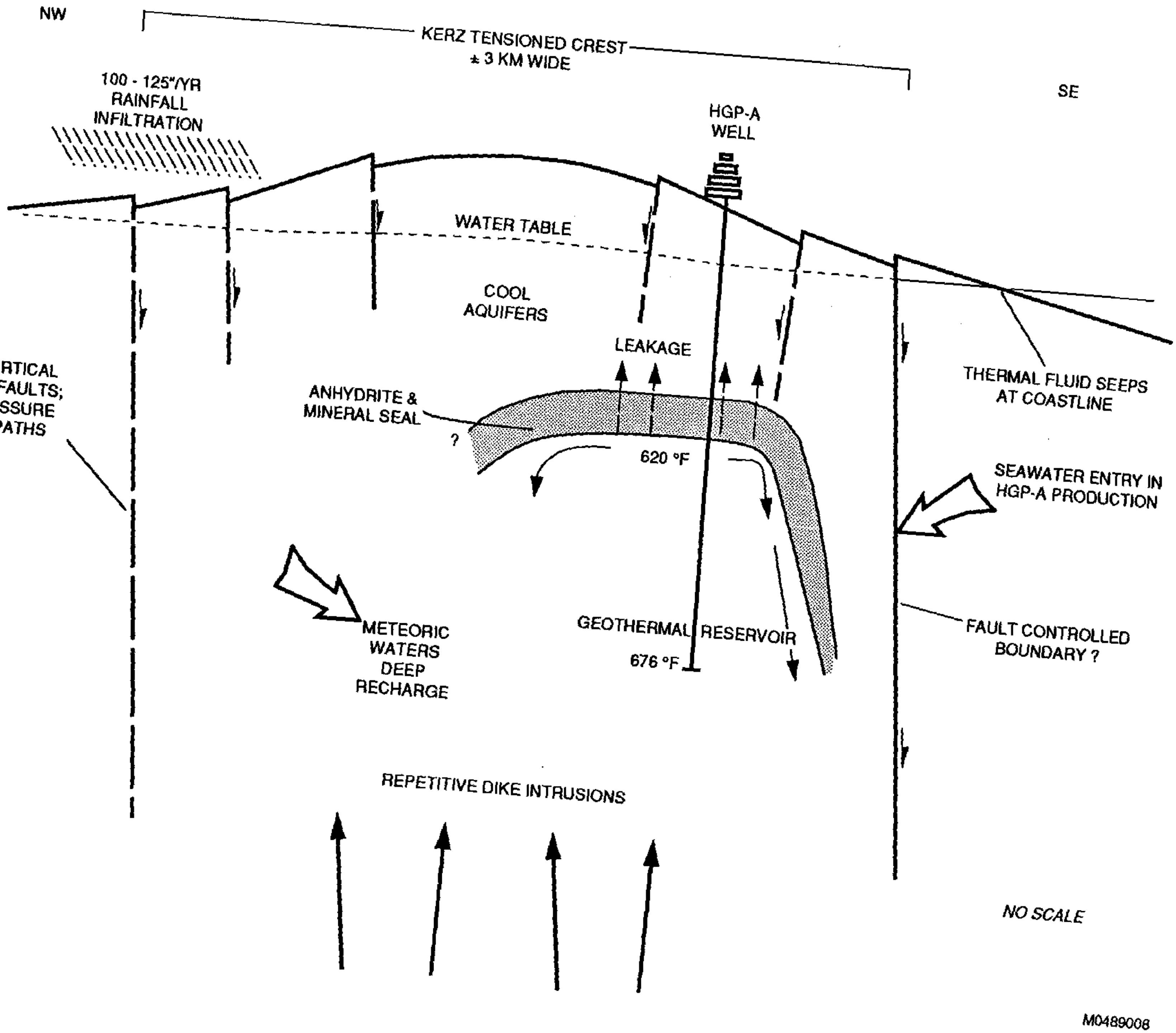
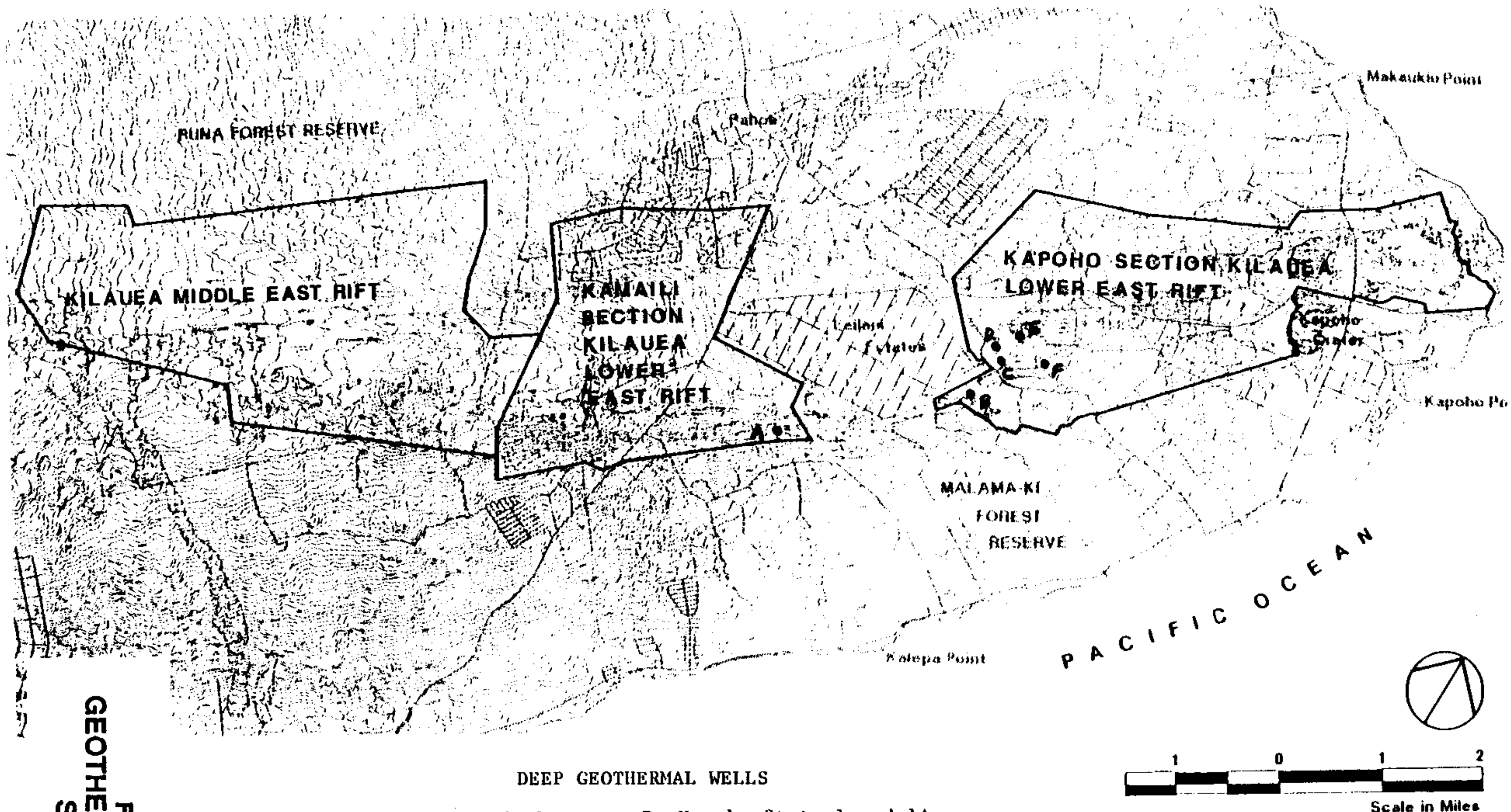


Figure A - 5
HYPOTHETICAL GEOTHERMAL
RESERVOIR IN KERZ



DEEP GEOTHERMAL WELLS

A Ashida 1

B Lanipuna 1 and redrill

C HGP-A

D Kapoho State 1 and 1A

E Kapoho State 2

F Lanipuna 6

FIGURE A-6
GEOTHERMAL RESOURCE SUBZONES

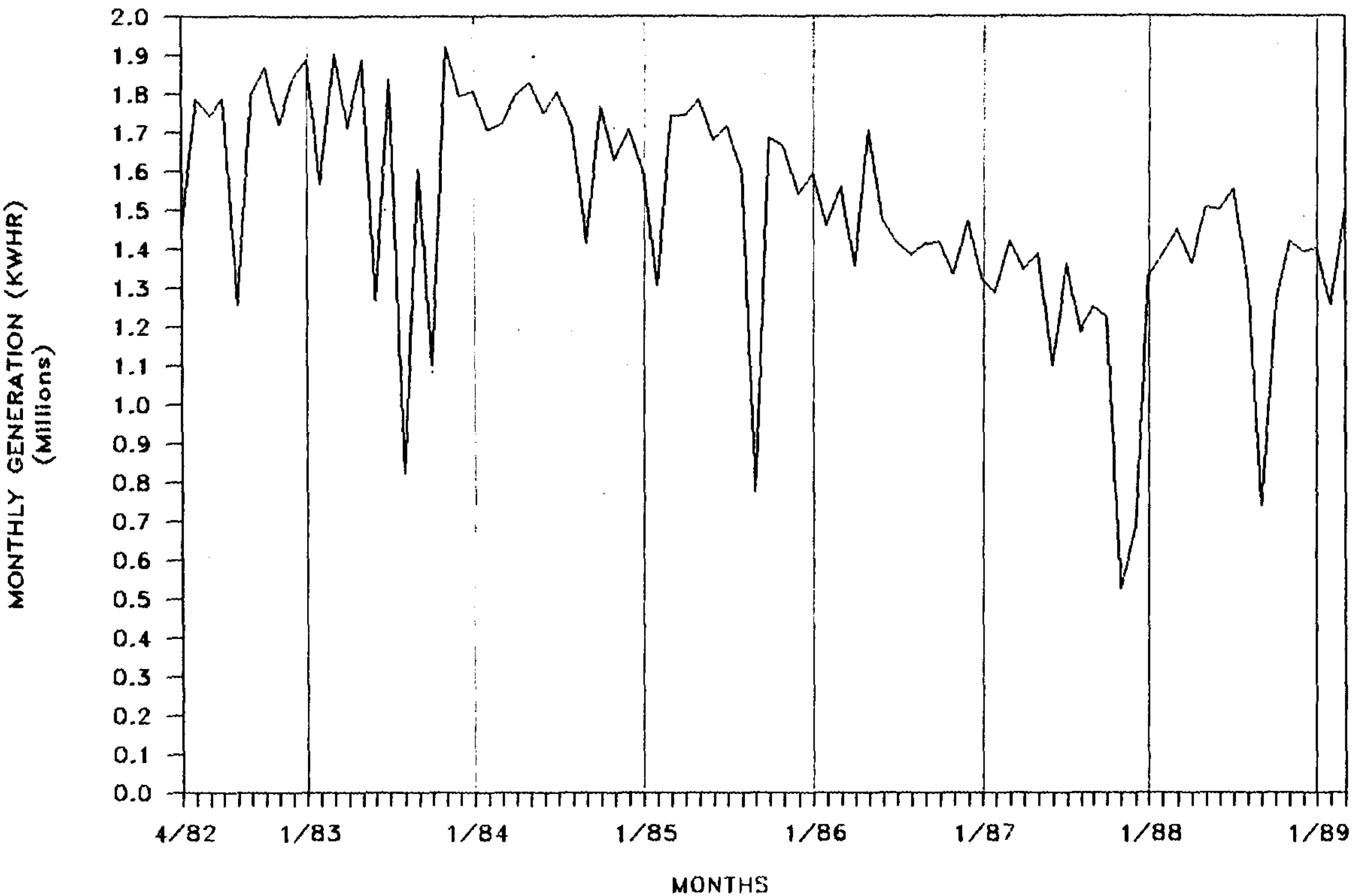
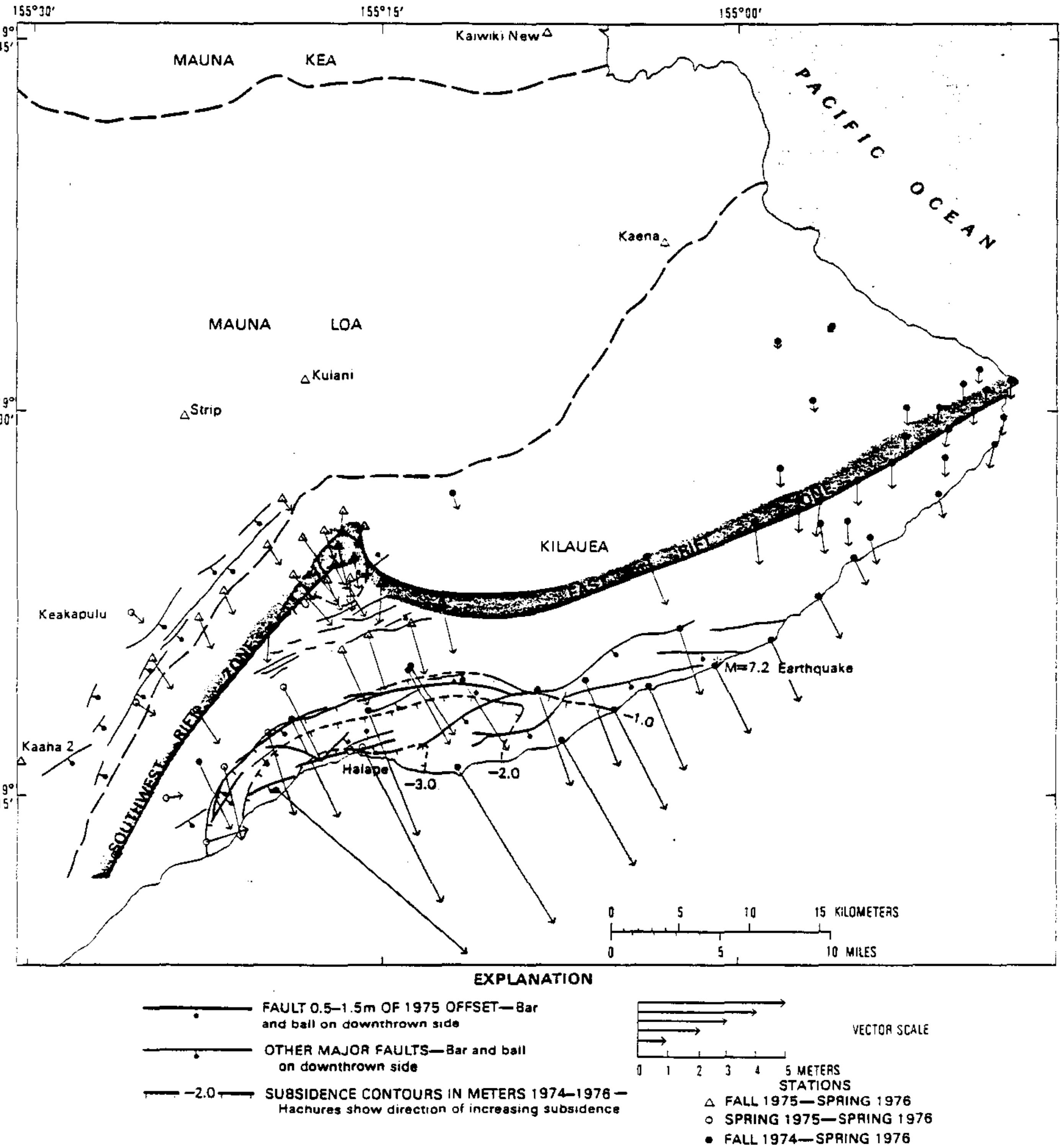


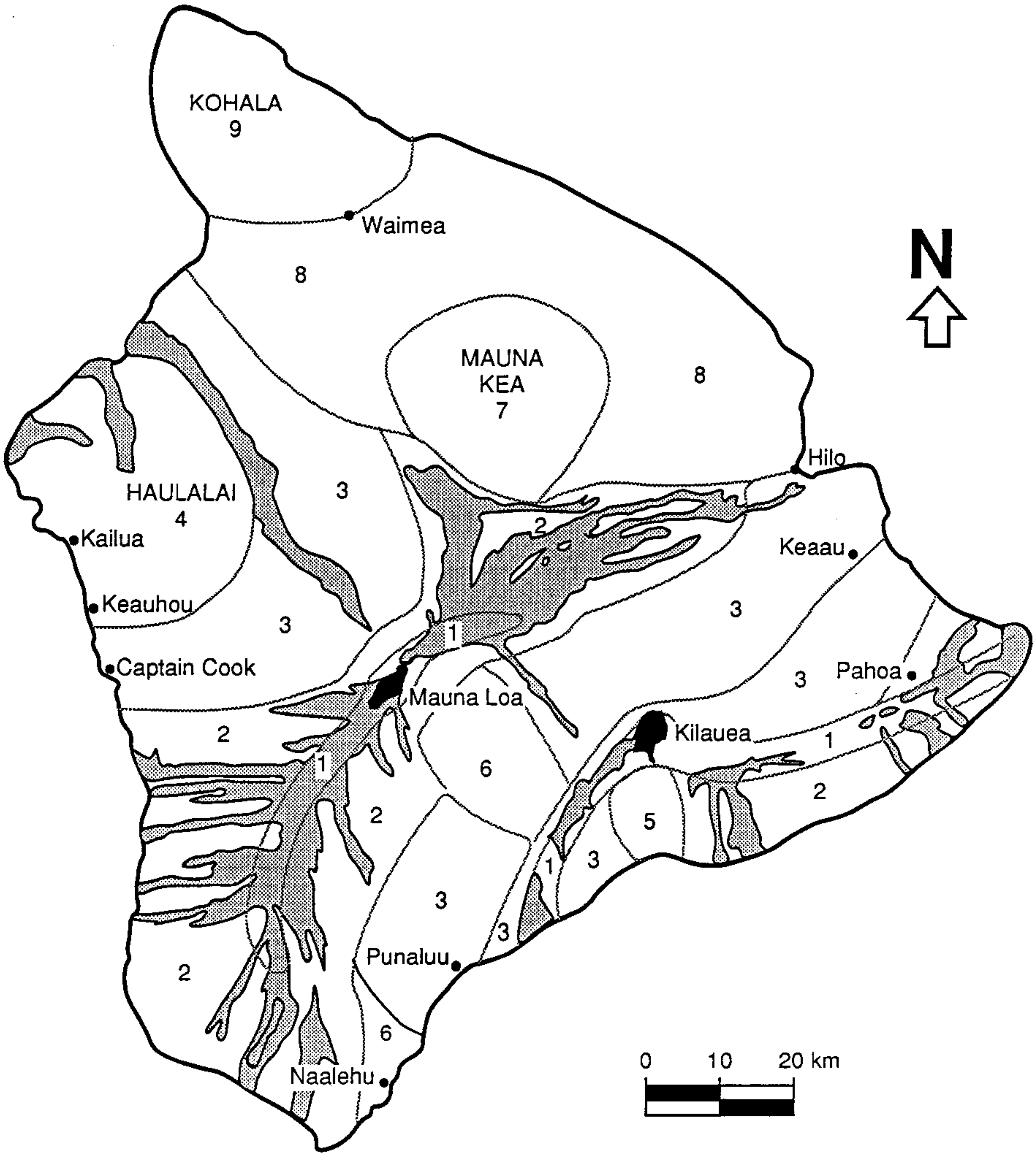
FIGURE A - 7
HGP-A OPERATIONAL
SUMMARY



(From USGS Professional Paper 1276: Lipman, et al, 1985)

Figure A - 8
DISPLACEMENTS ASSOCIATED WITH NOVEMBER 1975 EARTHQUAKE

M0489040



ZONES 1 - 9 IN ORDER OF DECREASING HAZARD

Figure A - 9
LAVA FLOW HAZARD ZONES

M0489011

APPENDIX B

PERMIT/ENVIRONMENTAL INFORMATION
for the
GEOTHERMAL/INTERISLAND TRANSMISSION PROJECT

Prepared from Public Records
by

G.O. Lesperance

STATE OF HAWAII
DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

April, 1989

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APPENDIX B

PERMIT/ENVIRONMENTAL INFORMATION
FOR THE
GEOTHERMAL/INTERISLAND TRANSMISSION PROJECT

B.1 PERMITS

B.1.1 GENERAL INFORMATION

B.1.1.1 DEVELOPER Responsibility/State Assistance

To the maximum extent practicable, the State of Hawaii, Department of Business and Economic Development (DBED) will assist the geothermal/cable DEVELOPER with the processing of applications for government permits and approvals. Respondents to this RFP should be as specific as possible concerning DBED assistance required. See Governor Waihee's letter to H.D. Williamson (attached following the Executive Summary).

DBED will maintain a Public Document Room during the period of this RFP. In addition, the Department of Land and Natural Resources (DLNR) will operate a permit information and coordination counter with a repository of laws, rules, procedures, permit requirements and agency criteria.

PROPOSERS may telephone DBED at (808) 548-4020 or facsimile (808) 531-5243 to reserve time in the public document room. The DLNR permit information and coordination center is located in Room 509, Gold Bond Building, 677 Ala Moana Boulevard, Honolulu, Hawaii 96813 and can be reached at telephone number (808) 548-7443 or facsimile number (808) 548-6233.

Act 301, Session Laws of Hawaii 1988 (SLH 1988), described later in this section, assigns the DLNR as lead agency to develop a consolidated (federal, state and the three counties) permit and application process for geothermal and cable development. That process will be in place in 1990 but it will be untested as a comprehensive and integrated process. All elements of the permitting system as it pertains to a modestly sized geothermal project in an Agriculture District within the Kapoho Section of the Kilauea Lower East Rift Geothermal Resource Subzone (GRS) and a terrestrial, one-county, AC transmission system will have been obtained by the end of 1990 in conjunction with Ormat Energy Systems, Inc., PGV 25 MW (net) project for sale of electricity to the island of Hawaii utility. By the end of 1990, True/Mid-Pacific Geothermal Venture is expected to have received most of the necessary permits and approvals for a geothermal project of up to 100 MW in a Conservation District within the Kilauea Middle East GRS.

B.1.1.2 Comprehensive Permit System

Act 301, Session Laws of Hawaii 1988, the Geothermal and Cable System Development Permitting Act of 1988, established a consolidated permit application and review system for geothermal and cable development. The DLNR is designated lead agency. All state and county agencies are required to participate in the system. Federal agencies are invited and have been participating. An interagency group has been formed, and a consolidated permit application form is being developed. Administrative Rules to implement Act 301 are expected to be approved by the Governor, State of Hawaii, in July 1989. A permit information and coordination center for this Project will be in operation during normal working hours. There is a repository of the laws, rules, procedures, permit requirements and criteria of agencies which have control or regulatory power over any aspects of this project.

B.1.1.3 Public Hearings

Public hearings are required for some state and county permits. A public hearing is a quasi-administrative (non-evidentiary) hearing at which written and unsworn oral testimony for and against issuing the permit is heard. Most, but not all, of the public hearings in Hawaii are subjected to the contested case provision which allows an aggrieved party to request a contested case (quasi-judicial or evidentiary) hearing. Public hearings for Conservation District Use Permits for geothermal development or for Geothermal Resources Permits are referred to mediation rather than contested case hearings. Appeals to decisions on these two permits are directly to the Hawaii Supreme Court. The PROPOSERS should account for these and other hearing requirements in developing time frames for the permit process.

B.1.1.4 International Waters

A portion of the proposed submarine cable crossing between Hawaii and Maui as well as between Maui and Oahu lies more than three miles beyond either island. The State of Hawaii asserted jurisdiction of these waters under the Archipelago waters concept. The U.S. Government does not recognize the State's claim. The PROPOSERS should consider the implications of this issue for permitting the Project.

B.1.1.5 Environmental Impact Statement

The DBED completed extensive environmental reviews for the cable system (August, 1987) and for the geothermal development (March, 1989). DBED continued this process by issuing on March 10, 1989, a Request for Proposals for the "Development of a Master Plan, Transmission Line Routing Study, and Environmental Impact Statement for Hawaii's Proposed Geothermal/Inter-Island Cable Project", included here as Appendix C. The master plan and transmission study should be complete by March 31, 1990. The EIS will be completed as soon as practicable after enough elements of the master plan and transmission routing report are available to initiate the environmental documentation process. The EIS will be prepared around a logical but theoretical development scenario. When applications for State permits are made, one or more EIS supplements analyzing actual development scenarios will need to be prepared by, and at the expense of, the Project DEVELOPER. The PROPOSER should address the likely need for an EIS in connection with government permits.

A U.S. Army Corps of Engineers Permit may be required for the ocean portion(s) of the interisland transmission system. The PROPOSER should discuss the need for a federal EIS, the expected time frame and the prospects for state coordination with the U.S. Army Corps of Engineers in preparing a single basis EIS document that addresses the concerns of both federal and state law regarding an EIS.

B.1.1.6 Geothermal Resource Subzones

Act 296, SLH 1983, the Geothermal Resource Subzone Act, amends Hawaii's Land Use Law (Chapter 205, Hawaii Revised Statutes) to direct the Board of Land and Natural Resources (BLNR) to make a county by county assessment, then designate Geothermal Resource Subzones (GRS) where there is significant geothermal potential and where the positive economic and social benefits of geothermal development outweigh the potentially negative environmental and social impact. Geothermal development activity, including exploratory drilling and power plant development, can only take place in a designated GRS. Two subzones, the Kilauea Middle East Rift and the Kilauea Lower East Rift including the Kamaili and Kapoho Sections, totalling 22,000 acres have been established in the Kilauea East Rift Zone on the island of Hawaii. One GRS was established in the Haleakala Southwest Rift Zone on Maui. The

Kapoho Section GRS abuts three small areas that were "grandfathered" as subzones because the State had issued mining leases before Act 296, SLH 1983, became law.

There are pending applications by a few landowners for the assessment of their land toward designation as GRS. For purposes of this RFP, a PROPOSER should not base the Proposal on the premise that additional GRS will be readily designated unless that PROPOSER has initiated action for such additional designations.

B.1.2 PERMITS FOR GEOTHERMAL RESOURCES, ENERGY GATHERING SYSTEMS, POWER PRODUCTION FACILITIES AND CONVERTER TERMINALS

B.1.2.1 Federal

There are no known federal permits required. No federal lands or funds are involved.

B.1.2.2 State

The preponderance of permits required for this geographical regime are state.

A Conservation District Use Permit (CDUP) is required from DLNR for geothermal development activity including exploration development or production of electrical energy from geothermal resources within the Conservation District. Essentially all of the Kilauea Middle East GRS, a portion of the Kamaili Section and a few small parts of the Kapoho Section are in the Conservation District. The CDUP requires a public hearing which, if contested, goes to mediation. Appeals are directly to the Hawaii Supreme Court. This permit is discussed in Chapter 205, Hawaii Revised Statutes (HRS) and DLNR Administrative Rules, Title 13, Chapter 184.

The DLNR requires a mining lease (technically not a permit), exploration permits, plan of operations, geothermal well drilling permit, modification of geothermal well for injection use permit, abandonment of geothermal well permit, and a permit to drill, deepen, redrill, plug or alter a water well and to install, replace or modify a pump. These permits are collectively discussed in Chapters 177, 178 and 182, Hawaii Revised Statutes as well as in DLNR Administrative Rules, Title 13, Chapter 166 (the water well permit) and Chapter 183 (the first five listed permits).

The Department of Health (DOH) requires an Underground Injection Control (UIC) Permit (40 CFR 122 and 156; Chapter 340 E, HRS; and DOH Administrative Rules, Title 11, Chapter 23). The Director of Health has the option of holding a Public Hearing before issuing a UIC Permit. DOH issues Authority to Construct and Permit to Operate Wells and Power Plants under the Clean Air Act (Clean Air Act; Chapter 342 HRS; and DOH Administrative Rules, Title 11, Chapter 59 and 60). The DOH has proposed changes to Title 11, Chapter 59, and 60 relating to geothermal air quality permits. The Director of Health has the option of holding a Public Hearing before issuing an Authority to Construct or Permit to Operate.

DOH is responsible for compliance with the Prevention of Significant Deterioration requirements under the Clean Air Act.

DOH also administers permits for Underground Storage Tanks.

The Department of Labor and Industrial Relations (DLIR) exercises Occupational Safety and Health Administration (OSHA) functions within the state. These responsibilities include permits for any pressure vessel/boiler (Chapter 397, HRS; DLIR Administrative Rules, Title 12, Chapter 210, 220-224).

The Department of Transportation (DOT) requires a permit to perform work upon a state highway. The DOT also requires a permit for the movement of oversize and overweight vehicles on state highways.

B.1.2.3 County

The County of Hawaii Planning Commission Rule 12 requires a Geothermal Resource Permit for geothermal development activity including exploration, development or production of electrical energy from geothermal resources in Agriculture, Rural and Urban Districts. This permit requires a public hearing which, if contested, goes into mediation. Appeals go directly to the Hawaii Supreme Court.

The counties require building, electrical, plumbing, and grubbing/stockpiling permits. Some counties require permits to use county streets.

Each county has their own permit requirements to perform work on a county street or highway and for the movement of oversize and overweight vehicles.

B.1.3 PERMITS FOR INTERISLAND ELECTRIC TRANSMISSION SYSTEM

B.1.3.1 Federal

Only one likely federal permit has been identified, a U.S. Army Corps of Engineers Permit under the Clean Water Act, Section 404, for the submarine cable portion(s) of the system. This permit may generate the requirement for a Federal (NEPA) EIS. See Section B.1.1 for further discussion of the EIS process. When a Federal permit is required, several federal agencies will review aspects of the project for compliance with the federal statutes. These may include but not be limited to the Rivers and Harbors Act of

1899, Section 10, Marine Mammal Protection Act; and Endangered Species Act, Section 7.

B.1.3.2 State

The DLNR will require a Conservation District Use Permit (CDUP) for any portion of the transmission system traversing a Conservation District. A public hearing will be required which, if contested, could generate a quasi-judicial contested case hearing.

DLNR also manages the Natural Area Reserve System, Historic Sites and State Parks and State Forests. Permission would be required of DLNR to transverse these areas. These permissions could generate public hearings and, if contested, contested case hearings.

DLNR also manages State of Hawaii submerged lands. The ocean bottom is considered submerged lands. Submerged lands are within the Conservation District and their use will require a CDUP. Section 171-53, HRS, requires that BLNR obtain the permission of the Governor and the Legislature before leasing submerged lands. The Legislature's permission would have to be obtained by a Concurrent Resolution. The regular sessions of the Legislature are held only from the third week of January through the third week in April each year.

Act 301, SLH 1988, transferred to the DLNR for purposes of the geothermal/cable project permitting, authority for the Ocean Waters Construction Permit which would otherwise be a DOT responsibility. The Act also transferred to DLNR, for purposes of the geothermal/cable project permitting, the Land Use Commission's (LUC) responsibilities. The LUC approves amendments to land use district boundaries, for instance, changing a particular parcel from the Conservation to the Urban District. As a practical matter, it is unlikely that this transfer of responsibility will matter with the geothermal/cable project. Act 296, SLH 1983, authorized the establishment of Geothermal Resource Subzones without regard to existing land use district boundaries. Ordinarily, transmission lines can be installed in any land district without the need for boundary changes.

B.1.3.3 <u>County</u>

The interisland transmission system will traverse three counties. Permits will be required from each.

Each of the three counties will require a Special Management Area (SMA) Use Permit and a Shoreline Setback Variance at the points where the transmission system crosses the land-ocean interface: one on Hawaii; two on Maui; and one on Oahu. These two permits are processed concurrently by each county. Further, they normally precede any necessary state or federal land approvals. For instance, the BLNR will probably not issue a CDUP for laying the cable on the ocean bottom until the county permits are issued. The U.S. Army Corps of Engineers ordinarily will not issue a permit until both state and county permits are obtained. These two county permits will generate public hearings subject to the contested case hearings in each of the three counties.

The City and County of Honolulu will require a Conditional Use Permit for any structure that contains an office, storage or maintenance facility. This permit generates two public hearings. It normally precedes the SMA permit.

A Zoning Waiver (Height) may be required by City and County of Honolulu as well as the County of Maui.

The City and County of Honolulu will require a Development Plan Amendment to change to the Public Facilities Map. Amendments to the Development Plan generate two public hearings. Approval of the Planning Commission, City Council and Mayor are required. There is a minimum 16 month processing time.

Each county will require various permits for building, electrical and plumbing work, driveway construction and street usage (special duty police officers for traffic control).

B.2 ENVIRONMENTAL INFORMATION

Environmental as used herein is generic, incorporating existing physical, biological, social, and cultural conditions at the sites which might be impacted by the proposed development. The primary purpose of the following sections is to provide proposers with general information developed to date by the State of Hawaii and others which will suggest the most probable environmental issues. Considerable data has been collected about the Kilauea East Rift Zone/Puna District where the geothermal development, including power production facilities, will occur. Proposers should review the bibliography to this section. All publications listed in the bibliography are available in the public document room.

B.2.1 TERRESTRIAL ENVIRONMENT

B.2.1.1 Soils, Geology, Seismic, Volcanic

Kilauea East Rift Zone

Kilauea on the island of Hawaii is still in a very active shield building stage. Since January, 1983, volcanic activity has centered on Puu O'o in the Upper East Rift Zone. The rocks of Kilauea are very porous and highly fractured. Evidence of local eruptive activity, lava flows, devastated areas and steam vents are found throughout the zone. The geologically older, low-lying fields in the zone are covered with fertile soil and lush vegetation while the younger uplands are sparsely covered with immature soils and dotted with Ohia trees.

Geologic hazards in the zone may include lava flows, tephra falls, volcanic gases and pyroclastic surges, especially in the Kilauea upland. Below grade lava tubes from past flows are a potential problem throughout the Kilauea East Rift Zone. Indirect results of volcanic activity are possible including earthquakes, ground fractures and subsidence. Because the Geothermal Resource Subzones (GRS) do not extend to near the shoreline, tsunamis are not likely to be a concern.

The three GRS are located in Lava Flow Hazard Zone 1, the highest risk zone of the nine hazard zones on the island of Hawaii. The island of Hawaii is an area classified by the Uniform Building Code as Seismic Zone 3.

Subsidence due to withdrawal of geothermal fluids does not seem to be a major concern.

Island of Hawaii other than the Kilauea East Rift Zone

The southern two-thirds of the Island of Hawaii is considered a high risk area for active volcanism. The risk decreases in a southerly direction. No volcanic activity has occured in North Kohala for about 50,000 years.

The tsunami of April 1, 1946, caused the water to rise 14 feet above sea level at Mahukona but did no damage. Mahukona is considered a likely exit point for the interisland transmission system. There is at least one report that before the first wave, the sea had lowered as much as 35 feet. The water rose gently, like a tide, without breakers.

Maui

All of Maui is in Seismic Zone 2. East Maui consists of the Haleakala dome which reaches 10,000 feet elevation and maintains a cliff and valley formation from the summit to the sea. The southwest rift zone of Haleakala is inactive but "geologically recent". The April 1, 1946, tsunami generated heights of 10 to 13 feet above sea level.

Oahu

The Waimanalo Plain on the windward side of the Koolau Mountain Range has mostly smooth slopes of less than 10 percent. All of Oahu is in Seismic Zone 1. The Waimanalo Plain is not a volcanic risk area. The April 1, 1946, tsunami caused a rise of 37 feet above normal, the highest on Oahu, on the north side of the Makapuu Head.

B.2.1.2 Meteorology and Air Quality

Kilauea East Rift Zone (KERZ)

Westerly (night time drainage) winds occur with the greatest frequency. Northeast daytime trade winds occur with the second greatest frequency. Night time winds average 2.8 meters per second (m/s) velocity and daytime 3.8 m/s. Average temperature is 22.2°C with little seasonal variation. Total annual precipitation exceeds 2000 mm, with winter and spring having slightly more rainfall than spring and summer. Up to a terrestrial elevation of 900 meters, annual precipitation increases significantly with elevation. Average relative humidity is 91 percent. Except for periods of heavy rains, severe weather rarely occurs. Thunderstorms average only 8 per year, and are rarely severe.

The U.S. Environmental Protection Agency has established atmospheric stability classes ranging from A, the most unstable, to F, the most stable. Class D indicates neutral stability conditions. Atmospheric mixing, and hence dispersion, is greatest during unstable conditions. In the Kapoho area, on an annual basis, neutral atmospheric conditions (Class D) occurred 50 percent of the time, slightly unstable (Class B and C) occurred about 25 percent of the time, extremely stable (Class E) about 20 percent, and unstable (Class A) less than 4 percent.

Average morning mixing heights at Hilo Airport range from 883 to 1555 meters and average afternoon heights from 909 to 1999 meters.

H_2S has been continuously monitored at four sites in Kapoho since 1981/1982. The maximum 1-hour H_2S was 68 micrograms per cubic meter.

Data on inhalable particulate matter less than 10 microns (PM_{10}) has been collected on a long-term basis in Kapoho and in the Hawaii Volcanoes National Park. The maximum 24-hour PM_{10} concentration in Kapoho was 19.0 micrograms per cubic meter on August 11, 1984, and in the Volcano National Park was 17.8 micrograms per cubic meter on July 23, 1984.

An extensive one-year air quality baseline survey was conducted in the KERZ in 1982/1983.

Air quality impact analysis has recently been conducted for six different scenarios of twelve 55 MW (gross) geothermal power plants within the three GRS of the KERZ. One scenario, consisting of four 55 MW power plants in each of the three GRS, was subjected to air quality impact analysis to estimate pollutant concentrations from the plants and to assess the significance of impacts in regard to applicable ambient air quality and increments.

All modeling results seemed to indicate the PM_{10} impacts would not be a limiting factor in geothermal power plant siting unless the cooling tower makeup water was extremely poor in terms of total dissolved solids concentrations. Maximum SO_2 concentrations did not appear to be a limiting factor in the siting of power plants in the Puna District. Each of the seven H_2S emission control technologies (Burner/Scrubber, Stretford, LO-CAT, Claus-SCOT, Selectox/CI, Clinsulf and Reinjection) that were modeled yielded acceptable impacts in relation to the proposed State of Hawaii H_2S increment of 35 micrograms per cubic meter. Under the worst case normal operating condition emission scenario, impacts were only slightly greater than the proposed Hawaii emission limit of 150 grams per megawatt hour.

Other than Kilauea East Rift Zone

Hazardous weather consists of strong tradewinds, kona (southwest) winds, tropical cyclones, and hurricanes. Winds greater than 10 m/s occur on the average 92 d/yr. Cyclones pass through the islands rarely, and then from the east. At least 20 hurricanes or tropical storms (33.4 m/s or greater winds) approached within 480 km of the islands between 1950 and 1982. Hurricane Iwa, November 1982, with wind speeds reaching 117 mph, was considered a major disaster for Kauai and Oahu. Undersea communications cables and undersea pipelines were displaced during the high wave surges that accompanied Iwa.

Since 1813, 112 tsunamis have been observed in Hawaii and 16 have caused significant effects. The north shores of the islands are more susceptible to inundation than other coasts.

B.2.1.3 Hydrology/Water Quality

Kilauea East Rift Zone

Very little site specific hydrologic information is available for the Kilauea Middle East Rift GRS and the Kamaili Section of the Kilauea Lower East Rift GRS because economic necessity has not prompted detailed investigations. The nearest wells are the Pahoa wells, northeast of the Kamaili Section and the Keauohana wells south of the Kamaili Section. Both are similar in depth (740-805 feet) and both are used for domestic supply purposes. The Pahoa wells produce water of excellent quality and may be representative of all areas within these subzones northwest of the rift structure. It is thought that groundwater north of the rift zone flows to the ocean in a northeasterly direction, generally perpendicular to topographic contours. The Keauohana wells are somewhat warmer and more saline. Groundwater in and south of the rift zone in this area will be somewhat saline, depending upon the extent of seawater intrusion as well as geothermal leakage into the aquifer. Discharge to the ocean is direct in a southeasterly direction.

Hydrology of the Kapoho Section of the Kilauea Lower East Rift GRS is influenced by the transverse fault of the Kilauea East Rift at the southwest end of the section. Groundwater downgradient of the transverse break appears to be geothermally affected, displaying elevated temperatures and mineral levels. Groundwaters flow southwest. Permeabilities are high except for an ash layer near Kapoho Crater. Although there are no recorded wells north of the Kapoho Section, the high quality of the Pahoa wells suggests that groundwater quality may improve in a northerly direction.

Data from the HGP-A well suggest very limited interaction between the geothermal reservoir and the shallower groundwater aquifers. Changes in the chemical composition of HGP-A fluids suggest that either the seawater component of the reservoir has been increasing as fluids have been discharged from it or that the flash front is migrating out into the formation.

Surface and groundwater are not likely to be impacted during normal, uneventful drilling operations. However, groundwater in the vicinity of each new geothermal well should be tested during the drilling.

Based on the HGP-A well chemistry the brines would not be toxic to groundwater. However, geothermal fluids at other locations may have different chemistries.

Other than Kilauea East Rift Zone

The landforms of surface water drainage basins reflect the geologic age and rainfall in different parts of the Hawaiian Islands, and watersheds are typically small. For Maui, flooding of Pahihi Gulch at Huakini may occur during periods of heavy rainfall. For Oahu, most of the coastline is within the 100-year flooding zone. The inland areas on Oahu, where the transmission system preferred route would traverse, are not subject to flooding.

B.2.1.4 Noise

Kilauea East Rift Zone

Noise measurement data in the KERZ are very limited. An environmental noise survey was conducted as part of the Puna Geothermal Venture (PGV) Project Environmental Impact Statement at two residential locations near the PGV site in Pohoiki. Background noise levels during the survey ranged from 34.2 dBA (7 p.m.) to 53.2 dBA (5 a.m.), which exceeds the county night time noise guidelines of 45 dBA. The high background noise level was due to moderate winds and precipitation in the area during the noise survey.

The Occupation Safety and Health Administration (OSHA) requirements for the workplace specify that no worker should be exposed to 115 dBA for more than 15 minutes, or to 90 dBA for more than eight hours. The U.S. EPA (1978) recommends that noise limitations should conform, as an initial minimum, to the regulations issued by the U.S. Geological Survey for geothermal operations on federal lands; i.e., not to exceed 65 dBA at the lease boundary or one-half mile from the source, whichever is greater.

The County of Hawaii Planning Department noise guidelines specify 55 dBA during the daytime (0700 to 1900) and 45 dBA during the night time (1900 to 0700) as satisfactory for residential areas. Short duration (less than one second) impact noise limits are 10 dBA higher than either the daytime or night time limits but may not be exceeded more than 10 percent of the time in any 20-minute period.

Other than Kilauea East Rift Zone

The proposed overland corridors of the interisland transmission system encompass land used for agriculture, grazing, pasture land and rural residential areas. The background noise levels in these areas would normally be below 45 dBA.

During construction/deployment of the transmission system, the loudest example evaluated, a hovering helicopter, would generate up to 93 dBA at 100 feet. Increases in noise levels would occur on a short-term basis. Mitigation of this impact would be done through restriction of operating hours, and would probably be a condition attached to one or more necessary permits.

B.2.1.5 Fauna/Flora

Kilauea East Rift Zone

Twenty-one bird species have been recorded from the Geothermal Resources Subzones. Of the six endemic species, the Hawaiian Hawk or 'I'o is the only listed endangered species. The endangered 'O'u, considered the rarest of the surviving honeycreepers on the island of Hawaii, has been observed in the upper elevations of the Puna Forest Reserve in which the Kilauea Middle East GRS is located. In general, the other endemic species (Hawiian Thrush, 'Oma'o, 'Elepaio, 'Amaki hi, 'I'iwi, and 'Apapane) are found in this GRS.

Except for the native Hawaiian Hoary Bat or 'Ope'ope'a, an endangered species, all the other mammals found within the GRS were introduced by human beings either accidentally or intentionally. The bat probably occurs throughout the GRS, preferentially foraging in forest openings, along forest edges, or over bodies of water. The nocturnal habits of this species makes detection and observation difficult.

Inventories of invertebrate resources have not been included in biological studies. A fairly rich complement of native invertebrates, including relatively diverse arthropod communities, can be expected in the less disturbed vegetation types. Lava tubes may support cave invertebrates, some of which are candidates for endangered status.

Intact forests dominated by native flora species are of special concerns. Such forests are more likely to provide refuge for threatened and endangered plants and animals. Siting of access roads, well pads, power plants and other facilities on barren lava flows, areas of stand-level dieback and areas dominated by introduced plants, is preferred. Permits for development within forests are likely to require site-specific biologic surveys before clearing is undertaken.

Other than Kilauea East Rift Zone

The predominantly introduced vegetation of the low elevation areas of the Island of Hawaii corridor does not provide suitable habitat for endemic Hawaiian forest birds. The Hawaiian hawk (endangered, endemic), Hawaiian owl (endemic) and the Hawaiian hoary bat (endangered) are known to occur in the Hilo area.

The green sea turtle and hawksbill sea turtle, both endangered species are likely to come ashore briefly and for short distances, on all islands.

Streams are generally considered special habitats for native aquatic animals. The only perennial stream in the proposed transmission corridors is the Waiulaula Stream in the Kawaihae area in northwest Hawaii.

The Ahihi-Kinau Natural Area Reserve on Maui is the only wetlands within the general area of the proposed transmission corridors. This protected area has a system of brackish anchialine ponds.

Kipuka's, older forests surrounded by more recent lava, are of interest. They occur in the saddle between Mauna Kea and Mauna Loa.

B.2.1.6 Archaeological/Cultural

Kilauea East Rift Zone

Puna was one of the six ancient districts or moku of the Island of Hawaii. Traditional accounts relate that Puna was a rich agricultural region, a center of development of religion, and focus for myths concerning the goddess Pele.

The Kilauea Middle East Rift GRS probably does not contain any significant archaeological sites other than temporary shelters, trails and forest planting areas. There are some possible cairns at Heiheiahulu. Within the Kamaili Section there are no recorded archaeological sites. The Kapoho Section contains the largest number of sites or potential site areas. Most of these are at or near cinder cones. Kuukii Cinder Pit is where a heiau and spring have been recorded. Holua slides have been identified. Other identified archaeological sites have been inundated by the 1955 and 1960 lava flows.

In a 1982 survey, the Puna Hui Ohana identified 413 adult Hawaiians residing in lower Puna, predominantly in Hawaiian Beaches (42.5 percent), Pahoa (21.9 percent), or Kalapana (18.8 percent). The survey included 85 percent of the area population. Forty-two percent of the Hawaiians viewed the overall impact of geothermal development as bad (Hawaiian culture; historical sites; traditional religion; and hunting, fishing and gathering; plus the more typical concerns such as traffic, agricultural land, land taxes, physical environment, quakes, eruptive, plants and animals). Positive responses were generally around the theme that geothermal development is good for the economy.

A group of Pele practitioners opposed geothermal development on the grounds that it threatens Pele and Hawaiians' relationship to the goddess, Hawaiian relationships with the land and Hawaiian identity. When the Pele practitioners asked the Hawaii Supreme Court to stop geothermal development on religious grounds, the Court in July 1987 unanimously found that the plaintiffs did not show that development would do significant harm to the exercise of their religion. The U.S. Supreme Court, in April 1988, decided not to review the Hawaii decision.

Other than Kilauea East Rift Zone

The Historic Sites Section of the Department of Land and Natural Resources Parks Division lists historic and archaeological sites on both State and National Registers of Historic Places. There are eleven specific sites in the general vicinity of the proposed transmission route on Maui and nine on Oahu. There are numerous archaeological and historic sites on the island of Hawaii and there are believed to be many undiscovered sites island wide.

B.2.1.7 Land Use and Zoning

Kilauea East Rift Zone

The KERZ lies entirely within the 500 square mile Puna District. About 74 percent of Puna's land is unused open space of which less than 29,000 acres in Puna is actually being used for agriculture.

Puna has 51,000 vacant parcels, ranging in size from 4,000 square feet to 10,000 acres, with most larger than one acre. In the 1980 census, there were 5,529 year-round housing units.

In the Kapoho Section of the lower East Rift GRS, approximately 85 percent of the total 7,350 acres is unused open space. Residential use, all on agriculture-zoned land, accounts for less than one percent of the total area.

The Kamaili Section of the lower East Rift GRS is all zoned agriculture. Most of the 5,530 acre subzone is presently unused open space.

The 9,104 acre Kilauea Middle East Rift GRS is classified Forest Reserve. Over 600 acres in the southeast corner are in the agricultural district.

In Puna, about 148 acres are for commercial uses, including land for services.

A large number of large-lot subdivisions were created during the 1950s and 1960s. They were constructed on relatively recent lava flows and most, even today, lack county-standard roads, water and sewer lines. Some portions are not served by electricity or telephone lines.

Other than Kilauea East Rift Zone

With the exception of Hilo, the entire proposed cross-island transmission corridors on the island of Hawaii are rural in character, have a low population density, and are far from residential communities. There is rapid resort development in the Kohala coastal region. There are no major commercial or industrial activities along the route. There is a small residential area near the Kaumana substation. Kawaihae Harbor is a commercial deep draft port. Mahukona harbor is a dilapidated small boat harbor.

The proposed transmission corridor on Maui is presently very rural in character. The entire study area is within the 1980 census tract number 303.02 which has a land area of 45,442 acres, a resident population of 1,227 people and 474 households. This census tract includes the Kihei-Makena resort area which has experienced major population growth in the past fifteen years.

The proposed route on Oahu is also rural in character. Waimanalo is the closest urban center within 1980 census tract number 113 which has a land area of 7,100 acres, 1980 resident population of 9,132 people and 2,137 households.

B.2.1.8 Aesthetics/Visual Impact

Generally, the views from existing highways and roads are panoramic, predominantly rural and undeveloped, with the ocean often visible. Although few specific viewsheds are protected by land use laws, preservation of visual quality is a statewide goal. No formal ordinances exist concerning visual resources for the study areas. However, sightseeing is a popular activity for tourists, which represent Hawaii's largest industry.

B.2.1.9 Social/Economic

Kilauea East Rift Zone

Puna's economy is distinctive for the Island of Hawaii in that it lacks major tourism investment and no longer produces sugar. Diversified agriculture, including papayas, macadamia nuts, bananas, flowers and foliage, has taken an increased importance.

Puna residents often stress that they like the relatively undeveloped character of the district but they are concerned about the availability of jobs and limited infrastructure. Residents describe themselves as rural or as having a rural life-style.

A 1986 survey showed 66 percent of the residents favoring and 18 percent opposed to small-scale geothermal development to serve the island of Hawaii, but were nearly evenly divided concerning large-scale geothermal development including export to Oahu.

There is significant concern about decrease in residential land values with large-scale geothermal development.

Other than Kilauea East Rift Zone

Much of the Kohala District on the island of Hawaii is being developed into expensive resorts and ranches. This area is predominantly flatland-ridge/grassland landscape where transmission structures would often be in silhouette against the sky or a distant background form lacking visible texture.

B.2.2 MARINE

B.2.2.1 Bathymetry

About 80 percent (178 kilometers) of the suggested submarine route is in less than 547 meter depths, 12 percent (27 kilometers) are between 547 and 1,094 meters and (all within the Alenuihaha Channel) 3.6 percent (nine kilometers) are between 1,094 and 1,641 meters and another eight kilometers between 1,641 and 2,188 meters. The proposed route was selected to avoid steep slopes. Where steep slopes could not be avoided, a route perpendicular to bottom contours was selected. The route also avoids areas of excessive bottom roughness to minimize unsupported spans and abrupt bending radii. Proposers are strongly urged to verify preferred route bathymetry by studying the bathymetric survey data available in the public document room.

B.2.2.2 Marine Biology

Within the general area of the proposed cable system occur the endangered Hawaiian monk seal, the endangered humpback whale, the threatened sea turtle, and occasionally, the endangered hawksbill, the threatened loggerhead, the endangered leatherback and the threatened Pacific ridley sea turtles. The Marine Mammal Protection Act of 1972 prohibits acts which unintentionally affect the natural behavior of marine mammals including non-threatened whales and dolphins that occur in Hawaiian waters.

Major beds of precious corals (pink, gold, bamboo and black corals) occur offshore at Mahukona (Island of Hawaii), Ahihi Bay (Island of Maui), in the Auau Channel between Lanai and Maui, and off Makapuu (Oahu).

Proposals should include a plan for analyzing impacts and addressing issues arising under the Endangered Species Act and other statutes.

B.2.2.3 Physical Oceanography

The summer wave climate is dominated by the strong northeasterly tradewind-generated waves as well as southern swell generated by distant winter storms in the southern hemisphere. The tradewind waves predominate in the Alenuihaha Channel. However, both wave types can occur simultaneously. The winter wave climate is characterized by a weakening of the tradewinds and the occurrence of infrequent southerly "Kona" storm waves as well as frequent northwesterly swells from North Pacific winter storms or mid-latitude low pressure systems. Alenuihaha is somewhat sheltered from the northwesterly swell but is directly exposed to southwesterly waves.

Below 300-400 meters predictable tidal current magnitudes and phases occur, although site-specific studies are recommended. In the open ocean, peak tidal currents are towards the SSW under the wave crest (high tide) and towards the NNE under the wave trough (low tide). Around the islands, however, the tidal waves interact with the island masses, creating mixed currents and eddies as well as flow intensification through channels.

Tides in Hawaii are predominantly semi-diurnal with diurnal inequality. Typical tidal currents are less than a half knot. Peak currents may reach one knot.

B.2.2.4 Navigation/Ocean Uses

The proposed submarine route is outside of major U.S. and foreign shipping lanes except in the Molokai Channel. There are interisland tug and barge services, luxury liners and numerous smaller private vessels.

The U.S. Navy is a significant user of the seabed, surface and subsurface waters around the Hawaiian islands, and has established two area classifications for use: Warning Areas and Fleet Operating Areas. The only restricted area near the proposed cable system is the ocean area of three miles surrounding the Island of Kahoolawe. The proposed cable route avoids this area.

The military maintains communications and other cables in offshore Hawaiian waters. Once a final route is selected for the interisland tranmission cable system, the Navy should be contacted to provide information regarding potential conflicts. Similarly, Hawaiian Telephone Company and other private communication companies should be contacted once a final route is selected to avoid potential conflicts.

The most valuable commercial fishery in Hawaii is tuna longlining with the second largest being live-bait, pole-and-line for skipjack tuna. In 1981-1982, roughly 200 vessels (predominantly commercial charter-fishing) indicated they trolled commercially in Hawaiian waters and 1,000 additional boats and fishermen indicated that they combine trolling with other types of commercial fishing. An estimated 250 small boats are in the tuna handline fishery.

There is a network of Fish Aggregating Devices (FADs) anchored buoys, around the islands; however, the preferred route avoids existing FADs by three miles.

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APPENDIX C

March 10, 1989

REQUEST FOR PROPOSALS

DEVELOPMENT OF A MASTER PLAN, TRANSMISSION LINE ROUTING

STUDY, AND ENVIRONMENTAL IMPACT STATEMENT FOR

HAWAII'S PROPOSED GEOTHERMAL/INTER-ISLAND CABLE PROJECT

This letter is to invite your proposal to prepare a Master Development Plan, conduct a public involvement program, conduct an evaluation of overland transmission corridors and prepare a routing report, conduct a public involvement program, and prepare an Environmental Impact Statement for the development of 500 megawatts (net) of geothermal resource in the Kilauea East Rift Zone on the Island of Hawaii and transmit it to Maui and Oahu via an inter-island electrical transmission system. The Master Development Plan is desired by the end of 1989. It is expected that the location and selection of overland transmission line corridors will take place in 1989, with the preparation of routing report to be completed in 1990. It is expected that this routing study be conducted with the full benefit of a public involvement program. With the completion of the master plan and routing work, the State desires an Environmental Impact Statement which will lead to the permitting of the project. Permitting assistance will be requested as a separate additive proposal item under this solicitation.

Proposals are due no later than April 13, 1989.

The attached Notice of Intent to Respond is due no later than March 29, 1989.

Attached, for your information and use, is a brief description of the purpose and intended scope of this project. Any questions concerning this Request for Proposals shall be addressed to:

Director, Department of Business and Economic Development
Attn: Maurice H. Kaya, Energy Program Administrator
335 Merchant Street, Room 110
Honolulu, Hawaii 96813
Tel: (808) 548-4150

Roger A. Ulveling

Director of Business and
Economic Development

March 10, 1989

REQUEST FOR PROPOSALS

DEVELOPMENT OF A MASTER PLAN, TRANSMISSION LINE ROUTING STUDY, AND ENVIRONMENTAL IMPACT STATEMENT FOR HAWAII'S PROPOSED GEOTHERMAL/INTER-ISLAND CABLE PROJECT

The State of Hawaii's Department of Business and Economic Development (DBED) invites proposals to prepare a Master Development Plan, conduct a public involvement program, evaluate overland transmission line corridors, prepare a routing report, and prepare an Environmental Impact Statement for the development of 500 megawatts (net) of geothermal resource on the Island of Hawaii and transmit it to Oahu and Maui via an inter-island cable system, hereinafter called the geothermal/cable project. Included as an additive proposal item is the preparation and submission of Federal, State and County permit applications. Seven copies of the proposal are due on, or before 4:00 p.m., HST, on April 13, 1989. The proposals shall be mailed or delivered to:

Director, Department of Business and Economic Development
335 Merchant Street, Room 110
Honolulu, Hawaii 96813

Attn: Maurice H. Kaya
Energy Program Administrator

I. INTRODUCTION

A. PURPOSE

The purpose of this Request for Proposals is to select a consultant to perform planning and engineering functions relating to the geothermal/cable project to guide public and private decision-making relative to the implementation of the project. During 1989 and 1990, the State of Hawaii and the Hawaiian Electric Company, Inc. (HECO) will be requesting, receiving and evaluating proposals for the private sector to finance and implement the geothermal/cable project. The Master Development Plan to be developed as a result of this RFP will assist that process.

The development of this plan must consider the multitude of reports and studies that have already been conducted to date regarding geothermal and deep water cable development in Hawaii. This project has not been without controversy, and the preliminary work that has been done has revealed concern particularly by those communities in the lower Puna district of the Big Island, over the impact of this widespread development on their neighborhoods. It is therefore expected that the public in potentially affected areas of all counties would want to have input in the planning for this project.

Despite the controversies, the State recognizes the importance of developing its geothermal resource to its fullest potential to achieve a significant degree of energy independence. Private development of the resource has been slow, and the State believes that it is necessary to conduct this planning to show leadership and commitment, to invest in the upfront engineering activities so that an eventual private development consortium will assume responsibility for financing and development and sale of electricity to HECO.

B. BACKGROUND

Hawaii's deep concern for its energy future is a result of the State's extremely high reliance upon petroleum in an unstable world market. Despite the current world oversupply and the recent decline in price, there is widespread opinion that the current worldwide surplus oil production capacity will likely be exhausted in less than a decade. Thereafter an escalation in oil price is expected. Energy experts differ greatly as to exactly when and how rapidly prices will rise. This uncertainty emphasizes the need for Hawaii to take active measures to reduce its oil dependence and improve its energy stability and security. This need becomes imperative in the light of the serious negative impact of high energy costs on our State economy.

Petroleum accounts for ninety percent of Hawaii's total energy supply, twice the national average. In the case of electrical power generation, the contrast between Hawaii and the rest of the nation is even greater. While the nation's utilities have reduced their use of oil to a point where petroleum products now account for only about five percent of the fuel consumed for power generation, Hawaii's utilities have continued to rely almost entirely on oil. Nationally, coal is the leading source of energy for power generation, accounting for fifty-six percent of the fuel used. Locally, coal will be used for the generation of power on Oahu for the first time starting in 1992.

Recognizing Hawaii's energy vulnerability, the Hawaii State Plan, adopted by the State Legislature in 1978, sets forth the following energy objectives: Dependable, efficient, and economical statewide energy--systems capable of supporting the needs of the people; and increased energy self-sufficiency.

To meet the objectives stated above requires serious consideration of the use of locally available energy resources. There are several candidates in various stages of technical maturity. However, geothermal energy is the only near-term indigenous source which can bring about significant energy self-sufficiency in Hawaii.

Geothermal energy has proven to be technically and economically feasible elsewhere. Scientists estimate that there is sufficient thermal energy on the Big Island to satisfy at least half of the State's total electricity requirements. Because geothermal resources are located primarily on the Big Island, and Oahu represents eighty percent of the demand, successful utilization of geothermal energy requires transmission of electric power between the Islands. The most feasible method of transporting electricity under the conditions involved is by high-voltage, direct-current (HVDC) submarine cables. Such a transmission method has been under study for several years.

The Hawaii Deep Water Cable (HDWC) Program, a $27 million project funded by the Federal Government and the State, was started in 1980. Its purpose is to develop the technology of a cable system to transmit electricity between the islands of Hawaii. This requires a transmission cable capable of traversing a distance of 150 miles in ocean depths down to 6,300 feet. This is twice the distance and four times the depth of the longest and deepest cable laid to date anywhere in the world. The HDWC has produced a design for an electric transmission cable which is expected to satisfy Hawaii's requirements. A segment of a cable meeting design requirements has undergone electrical and mechanical testing in the laboratory. This testing demonstrated that the cable can withstand a thirty-year operating life under the design parameters identified for the Hawaii application. These laboratory tests are being followed by testing to confirm the validity of the subsystem integration plans in 1989 at sea with a six mile length of surrogate cable. The technical feasibility of a cable system for commercial application will be confirmed with the completion of these at-sea tests. Ocean bottom surveys have identified a feasible cable route linking Hawaii with Maui and Oahu.

The Hawaiian Electric Company, providing Oahu with electricity, will be the buyer of power produced and transmitted by the geothermal/cable project. It has confirmed that the utility system on Oahu is capable of accepting 500 megawatts of "competitively priced" baseload geothermal power phased in between 1995 and 2006. This is the basis upon which cable and geothermal development planning is proceeding. The cable system is estimated to cost about $450 million, with the geothermal development for 500 MW estimated to cost approximately $1.3 billion in 1986.

Private investments made to date for geothermal development in Hawaii exceed $20 million, although no commercial plant has yet been constructed. Presently there are two firms actively involved in geothermal development activities on the Island of Hawaii--Ormat Energy Systems, Inc., and True/Mid-Pacific Geothermal Venture. Ormat has entered into a contract with the Hawaii Electric Light Company on the Island of Hawaii to provide 25 MW of geothermal power by 1991 to meet the Island's needs. True/Mid-Pacific Geothermal Venture has been trying for years to get the necessary permits to start exploration for geothermal resources. Although one of the objecting parties are still in the courts, it is anticipated that its permits will soon be confirmed and it can at long last begin its work. It will have land-use approval for the development of up to 100 MW of geothermal power. True/Mid-Pacific has also indicated an interest in developing geothermal energy on Maui.

Development of geothermal energy in Hawaii has been slow, for a number of reasons. Temporarily depressed petroleum prices have discouraged alternatives. Private developers are reluctant to undertake the risk of large-scale geothermal exploration and development in the absence of an assured market. The market in turn depends upon the availability of an inter-island transmission system. Numerous and complex permitting policies and procedures as administered by various government agencies have hampered progress in development. Strong encouragement and cooperation by the State and Hawaiian Electric Company are required if geothermal energy is to provide some energy self-sufficiency for Hawaii.

The State Legislature has supported geothermal development in recent years by adopting several bills intended to encourage development. Bills to establish geothermal resource subzones, to address the requests for hearings on some geothermal development activities, to give the BLNR flexibility with respect to royalty payments to the State, and to streamline and provide for a consolidated permit application process have offered significant encouragement.

There is wide public support for geothermal energy development. An August 1987 opinion poll indicated that eighty-four percent of the statewide population favor geothermal development, with only seven percent opposed. On the Big Island, seventy-five percent were in favor of geothermal development while five percent were opposed.

II. SCOPE OF WORK

A. Master Plan

The State will prepare an EIS and may obtain master permits for the geothermal/cable project. It is necessary, therefore, to prepare a Master Development Plan of the project which includes, but is not limited to, the following elements:

1. Descriptions and elements of the Hawaii Deep Water Cable Program (HDWC).

2. Descriptions of the geothermal resource development, and plan for development of the steam fields and power generating stations, drilling requ`rements, resource exploration, and AC-DC converter stations.

3. Development of a realistic time schedule in critical path format for permitting, completion of the Hawaii Deep Water Cable Program geothermal exploration/reservoir assessment, public information/ public involvement, overland transmission line corridor selection, and private development of the geothermal wells, steam gathering systems, power plants, converter stations, overland transmission lines and submarine cables.

4. Describe the management structure and appropriate responsibilities of the organizations for each element of the project.

5. Identify critical path elements and the relationship they have in meeting the project timetable. Describe measures that could be considered to facilitate meeting project timetables. Consult with the DLNR, who is responsible for implementing the streamlining and consolidation of the permitting for the geothermal/cable project and identify the needed permits and responsible agencies involved in permitting the overall project.

6. Provide descriptions and cost estimates for each element of the project.

7. Describe the public involvement and community acceptance approach that formed the basis for decisions and recommendations comprising the master plan.

8. Describe the legal, financial and regulatory framework of the project, based on a review of past studies and reports. Recommend appropriate legislation or rulemaking that would be required to support, expedite, facilitate, or otherwise clarify the project in order to remove impediments. Further describe crucial roles for agency action that would facilitate private sector development.

The master plan must address specific characteristics of the project that reflect local, environmental, physical and cultural conditions. For example, development of the geothermal resource and siting of transmission line corridors must consider the effects of these facilities on environmentally sensitive constraints.

In addition to defining the project for the State and County permit process, the Master Plan, together with the EIS, will also form the basis for discussion and pre-application review by affected federal agencies for a National Environmental Policy Act (NEPA) EIS or applicable federal permitting actions.

B. Public Involvement Program.

Public acceptance of this project is determined to be critical for its successful implementation since a multitude of permits are anticipated to support the action. A comprehensive public involvement program is therefore desired as part of the scope of work. This public involvement program should include, but not be limited to the following:

1. Describe and analyze system requirements. Develop and describe the project purpose and need, and develop the project process. The detailed public involvement program plan should be developed as part of this task.

2. Develop and describe transmission line routing methodology. Identify and describe the sequence of steps that will be used in analyzing and selecting the ransmission line routes.

3. Describe and analyze transmission line alternatives. Identify, describe and analyze the basic options for linking the geothermal power plants overland, through each County jurisdiction, to the location of the delivered resource, Maui and Oahu Counties. The options shall include, as a minimum, overhead lines, underground lines and submarine cables.

4. Select overland corridors by identifying the criteria for corridor selection, collecting and analyzing broad-scale data factors, identifying potential corridors for potential further detailed study, developing evaluation criteria for corridor selection, evaluating and selecting the preferred corridor, and surveying and mapping conditions along the preferred corridor. The corridor selection process shall combine the technical expertise made available to the project with the consultation and active participation of the affected publics, including HECO, in the development of constraints and opportunities. Evaluation data categories should include, but not be limited to

exclusion areas, geophysical hazards, biological factors, socio-economic factors, and cost factors. The information already obtained by DBED to identify environmental constraints (see References) shall be made available to the consultant. The consultant will be responsible to review this information and advise whether additional work is necessary.

5. Alignment selection. This task will analyze and identify potential alignments within the preferred corridors using the constraints that are developed for analytical purposes. Where analysis of the trade-offs between constraints indicate that more than one alignment is feasible, all identified alignments shall be delineated. The consultant shall work with DBED to develop the rationale for selecting (i.e., selection criteria) the preferred alignment and the application of the rationale to select the preferred alignment. Public involvement for alignment selection is also considered to be a significant element in constraint development and acceptance.

6. Prepare a routing study. This document shall be a final report that will describe the details of the work performed in the above five tasks.

7. The consultant shall include in his public involvement program for transmission lines, appropriate coverage of the development of the geothermal resource to enable public understanding for the purpose of the project, and likely development scenarios. This task shall also include the identification of the need and schedules for public information programs, workshops, etc., and the preparation of materials for these programs. Materials to be prepared under this task shall include, but not be limited to, speeches, graphic presentations, newsletters, and handouts. The consultant shall recommend in his proposal, elements in this task that will lead to a better public understanding of the program, with a goal that increased public awareness will lead to a more effective public involvement campaign and acceptance during the permitting phase of the project.

C. Prepare Environmental Impact Statement

DBED has determined that an EIS is required under Hawaii Revised Statutes (HRS), Chapter 343, because the proposed action, which will involve the use of State lands and/or State funds, could have a significant effect on the environment based on the significant criteria set forth in Title 11, Department of Health, Chapter 200, Environmental Impact Statement Rules (Section 11-200-12b). Because federal permits may be required to install the facility, preparation of the EIS should be closely coordinated with the affected federal agencies in order to ensure that all NEPA requirements are fulfilled in the State EIS. The consultant shall recommend ways in which this EIS could also serve to fulfill NEPA requirements to expedite and facilitate federal permitting efforts that would be required. The preparation of the EIS should also be closely coordinated with the affected County Planning Departments to ensure that the statement adequately addresses impacts as required for the County's permit review.

Prior to starting the EIS process, a public scoping meeting(s) must be held to assure that all public concerns are addressed. Public input and informational meetings shall also be held during the development of the EIS. The proposer is expected to develop a plan that would capitalize on the public involvement work that precedes the preparation of this EIS in the routing study phase of the contract.

This scope item includes, but is not limited to:

1. Prepare Notice of Preparation; conduct needed field surveys and collect needed data either not currently available or not developed during the routing study. The State intends that the routing process develops most, if not all, of the environmental impact data needed for environmental documentation and review.

2. Hold informational hearings on each affected island.

3. Prepare Draft EIS, submit fifteen (15) copies of a review draft to DBED, and prepare 100 copies of the Draft EIS for submittal to OEQC.

4. Prepare written responses to all written comments to the Draft EIS. These responses will be prepared for signature by the Director, DBED, or his designated representative.

5. Prepare Final EIS, submit five (5) copies of a review draft to DBED, and prepare 150 copies of the Final EIS for submittal to DBED and OEQC.

D. Project Management

This task shall include all administrative, financial and technical functions including scheduling, costing, reporting, and enforcement of technical adequacy and quality assurance controls to maintain overall study costs, schedules, and technical information levels. The consultant shall prepare subcontractor's scopes of work and subcontract documents and monitor the subcontractor's performance on the scopes of work and subcontract to ensure that the quality and quantity of work meet the requirements of the contract with DBED. DBED reserves the right to approve all subcontractors proposed for portions of the work scope.

E. Permitting (Additive Proposal Item)

DBED has prepared a listing of anticipated permits that would be required for this project. This list is attached to this RFP, and includes permitting actions at the federal, State and county levels (note that three counties are involved). It is the respondent's responsibility to develop a list of all required permits and approvals required, using the developed master plan as a basis. The master plan and EIS must be prepared to support the permitting requirement although the work on both may proceed simultaneously. Hawaii is committed to full public disclosure in the land use permitting process. The respondent should anticipate the requirement to attend public hearings, provide supporting testimony and exhibits, and generally assist DBED during the process.

A proposal for this additive item should be included. DBED may initiate the permitting actions for this project, or the permitting may become the responsibility of the development consortium for the project. The contract for the master planning/EIS consultant agreement will be developed with enough flexibility to accommodate either course of action.

III. PROPOSAL GUIDELINES

1. Timetable. The State desires completion of the master plan and routing report by March 31, 1990. The State desires a preliminary master plan within six months from the notice to proceed. The completion of the EIS is desired as soon as practicable after enough elements of the master plan and routing report are available to initiate environmental documentation processes. A goal of this program is to complete the planning work so that it can be provided to a development consortium for the project which will be selected by the State and HECO by the end of 1990. The consultant is requested to develop an approach that will be responsive to this requirement.

2. Phasing. The State will receive proposals for the entire scope of services. The contract will be funded in two phases, with the first to be limited to a fee not exceeding $400,000. The total estimated cost range for these services is expected to be $850,000 to $1.2 million. Proposals should specify those scope elements that can be funded in the initial phase, for example, work on a preliminary master plan, development of a public involvement plan, and initiating the routing activities can be started in Phase 1. Funding for Phase 2 (the respondent's remaining elements in his comprehensive approach) is subject to DBED obtaining additional appropriations for this effort. Respondents shall advise DBED on a Phase 1 approach that would derive the maximum benefit to meet overall project objectives within the Phase 1 funding limitation.

3. The State reserves the right to reject any and all proposals.

4. The State reserves the right to organize its own "team" from proposed contractors and subcontractors. The State further reserves the right to approve each and every subcontractor.

5. It is anticipated that the selected respondent to this RFP will be given a notice to proceed 40 to 45 days after the date proposals are due.

6. Preparation of the proposals and the presence at an interview shall be at the respondent's own expense.

7. The respondent agrees that the proposal shall constitute a firm offer to DBED and cannot be withdrawn for sixty (60) calendar days after the due date for submission of the proposals. The respondent shall agree that prices listed are firm and shall remain so throughout the performance of the work.

8. Alternate scopes of service may be suggested. Justification for any major changes, including how they will accomplish the goals and purposes of the requirements, should be provided.

9. All changes to this RFP will be made by DBED in the form of written addenda sent only to those interested respondents who have completed and returned the NOTICE OF INTENT TO RESPOND attached hereto.

10. The proposal shall be signed by an individual authorized to bind the respondent. It shall include the name, title, address and the telephone number and facsimile number of individuals with authority to negotiate and contractually bind the company, and also who may be contacted during the period of proposal evaluation to answer any questions concerning their proposal.

11. Interviews may be held in DBED's offices in Honolulu after the derivation of a short list of qualified consultants. An opportunity will be provided DBED to meet key team members assigned to this project.

12. DBED reserves the right to contract for any, a portion, or all of the scope elements of this RFP. Accordingly, the proposal should be costed individually, by scope items.

IV. REQUIRED CONTENTS OF THE PROPOSAL

Proposals shall consist of two parts: Technical and Cost, for each proposal item. The technical portion of the proposal must include a complete description of the methodologies to be used and the tasks involved, including timetable estimates. The cost portion of the proposal must include estimated costs to accomplish the scope of work and all other associated costs.

The proposal shall be organized in the following sequence:

1. A statement of the respondent's understanding of the assignment and identification of the proposed approach, including methodology, special studies required, and consultants to be utilized. A detailed outline of the proposed technical approach for executing the requirements specified in the Scope of Services is required.

2. Statement and discussion of any anticipated major difficulties and problem areas, together with the potential or recommended approaches for their resolution.

3. Statement of any interpretations, qualifications, or assumptions made by the respondent concerning the work to be performed.

4. A schedule in graphic format of respondent's choosing that clearly shows the major tasks and milestones, including deliverables, in weeks after receipt of Notice to Proceed. This schedule should also show the relationship with Phases 1 and 2 and the listed tasks from the scope of work.

5. Description of the project team including the name, title, and qualifications of the project manager and other key participants in the employ of the respondent, as well as the name, qualifications and description of the role of each subconsultant.

6. Experience and qualification of the respondent and subconsultants, including but not limited to a description of comparable work previously performed by the project team.

7. Total cost to DBED by major budget categories showing: direct costs, including salaries, air travel, other travel-related costs, per diem, subconsultants, printing and other direct costs; and indirect costs such as overhead, profit and State of Hawaii General Excise tax. Fringe benefits related to direct salary costs may be included as direct costs or an element of overhead cost. The direct labor portion of the budget shall list each of respondent's participating professional or technical people by title, and if determined, by name, with the number of hours of that person's time that will be charged to DBED. The budget shall clearly differentiate costs related to Phase 1 efforts versus the remainder.

8. Assistance and/or information that will be required from DBED. Respondents shall note that the list of references included with this RFP reflect information already available from DBED. Respondents are advised that DBED desires that previous studies be utilized to full advantage in this master plan/EIS, and the State does not wish to replicate previous efforts.

V. EVALUATION FACTORS

A. General

1. Unless all responses are rejected, award shall be made to that responsible respondent whose offer, conforming to the RFP, is determined to be the best overall response, price or cost and other factors considered.

2. "Best overall response" is defined as the response that is evaluated as the most superior technically; however, in the event two or more competing proposals are assessed as substantially equal, the lower or lowest estimated cost shall be the determinant. "Substantially equal" proposals are those which do not demonstrate in DBED's or the State's judgement any clear and convincing evidence of technical superiority relative to each other.

3. An evaluation committee formed by DBED will evaluate the technical and cost portions of each proposal. (See evaluation checklist). If deemed necessary, the evaluation committee may conduct discussions with potential respondents. Final consultant selection for work scope and fee negotiations will be made by the Director of DBED.

4. Multiple awards. In addition to other factors, responses will be evaluated on the basis of advantages and disadvantages to the State that might result from making more than one award. If after evaluation of the offers, it is determined that one or more awards would be advantageous, individual awards will be for bid items or combination of bid items listed in the scope of work. DBED prefers single source contracting for this project.

B. Technical Evaluation

All proposals received will be evaluated using the following criteria:

1. Technical Approach:

   - Understanding of problems and tasks.

   - Responsiveness to scope, concept and time of performance.

   - Organization, with clear, concise articulation of the project.

   - Appropriateness to Hawaii's situation.

2. Technical Personnel Qualifications:

   - Sufficient personnel available to perform all tasks.

   - Available personnel experienced to perform all tasks.

3. Corporate Background/Experience/Location:

   - Prior experience in performing similar work.

   - Company presence in Hawaii or relation with local planning or engineering firm.

   - Ability to participate in and support DBED during public meetings.

C. Cost Evaluation

In evaluating the respondent's proposed cost for this project,DBED's concern is to determine whether (a) it reflects the respondent's understanding of the project and its ability to successfully organize and perform the contract, (b) it is based on adequate estimating procedures and is supportable and realistic in terms of the respondent's proposed technical approach, and (c) it is reasonable when compared to any similar complex work efforts. Technical considerations will be given priority over proposed cost. The proposed cost and budget for this planning effort should break down the hours of professional and technical time that will be devoted to the study and the proportion of the total cost that will be budgeted to productive direct cost.

D. Evaluation Check List

The following checklist will be used as a guide by the evaluation committee in determining the "Best Overall Response."

1. Size and resources of company - the availability of suitable resources to meet the objectives of this program in a timely manner.

2. Professional staff experience on projects of similar scope and complexity.

3. Documented experience in geothermal and high voltage transmission line planning, and environmental documentation.

4. Office location in Hawaii, or relationship with local planning, engineering, or environmental firms.

5. Selection of subcontractors who are technical experts in the necessary fields.

6. Scope of statements and discussion that would indicate understanding of anticipated major difficulties and their potential solutions.

7. Understanding of the assignment, identification of proposed approach, innovative concepts, and responsiveness to the RFP and its schedule.

8. Ability to assist the State in public meetings, processing permits and land use changes that might be required, etc.

9. Understanding of the nature of energy issues in Hawaii, the geothermal development, and siting and transmission line routing issues.

10. Familiarity with the local publics and agencies whose consensus would facilitate permitting of the program.

11. Management plan, including staffing quality, quantity, and availability including both prime and subcontractor personnel.

12. Qualifications and ability of the proposed project manager.

13. Program for making the affected community a part of the planning process.

14. Capability to define the legal and financial issues that are crucial to project success.

15. Fully understandable cost estimating procedures.

VI. REFERENCES

Hills, A.L., Hawaii Geothermal Project, Overview of Status, Development Approach and Financial Feasibility Assessment, Cogeneration Capital Associates for the Department of Business and Economic Development, July 1988.

Krasnick, G. and J. Mansur, HDWC Program, Phase II-C, Executive Summary, Parsons Hawaii, August 1987.

Lesperance, Gerald O., Geothermal Development in Hawaii, pp 75-79, Geothermal Resources Council, Transition, Vol 12, October 1988.

Mountford, J.D., HDWC, Phase II-C, Studies, Final Report for Hawaiian Electric Company, Vols. I, II, III, Power Technologies, Inc., May 22, 1987.

Patterson, Ralph A., Geothermal/Cable Development Project Planning, R.A. Patterson & Associates for the Department of Business and Economic Development, January, 1989.

Plasch, Bruce S., Undersea Cable to Transmit Geothermal-Generated Electrical Energy from the Island of Hawaii to Oahu: Economic Feasibility, Decision Analysts, Hawaii, Inc. for Department of Business and Economic Development, February 1988.

Quinn, William F., Preliminary Report, Governor's Advisory Board on the Underwater Cable Transmission Project, January 15, 1988.

Sumida, Gerald A., Preliminary Analysis: Legal, Institutional and Financial Aspects of an Inter-Island Electrical Transmission Cable, Carlsmith, Carlsmith, Wich an and Case and Prudential-Bache Securities, Inc. for the Department of Business and Economic Development, April 1984.

Sumida, Gerald A., Alternative Approaches to the Legal, Institutional and Financial Aspects of Developing an Inter-Island Electrical Transmission Cable System, Carlsmith, Case, Mukai and Ichiki and First Interstate Cogeneration Capital Associates for the Department of Business and Economic Development, April 1986.

Request for Proposals (RFP) for the selection of a consortium to develop the geothermal/cable project. This RFP is currently under preparation by a working committee with members from the Hawaiian Electric Company, Inc. (HECO), consultants to HECO, and DBED.

A consolidated permit application and review procedure for the geothermal/cable project, with the State's Department of Land and Natural Resources as lead agency, was established by Act 301, Session Laws of Hawaii, 1988 (Geothermal and Cable System Development Permitting Act of 1988).

VII. ATTACHMENTS

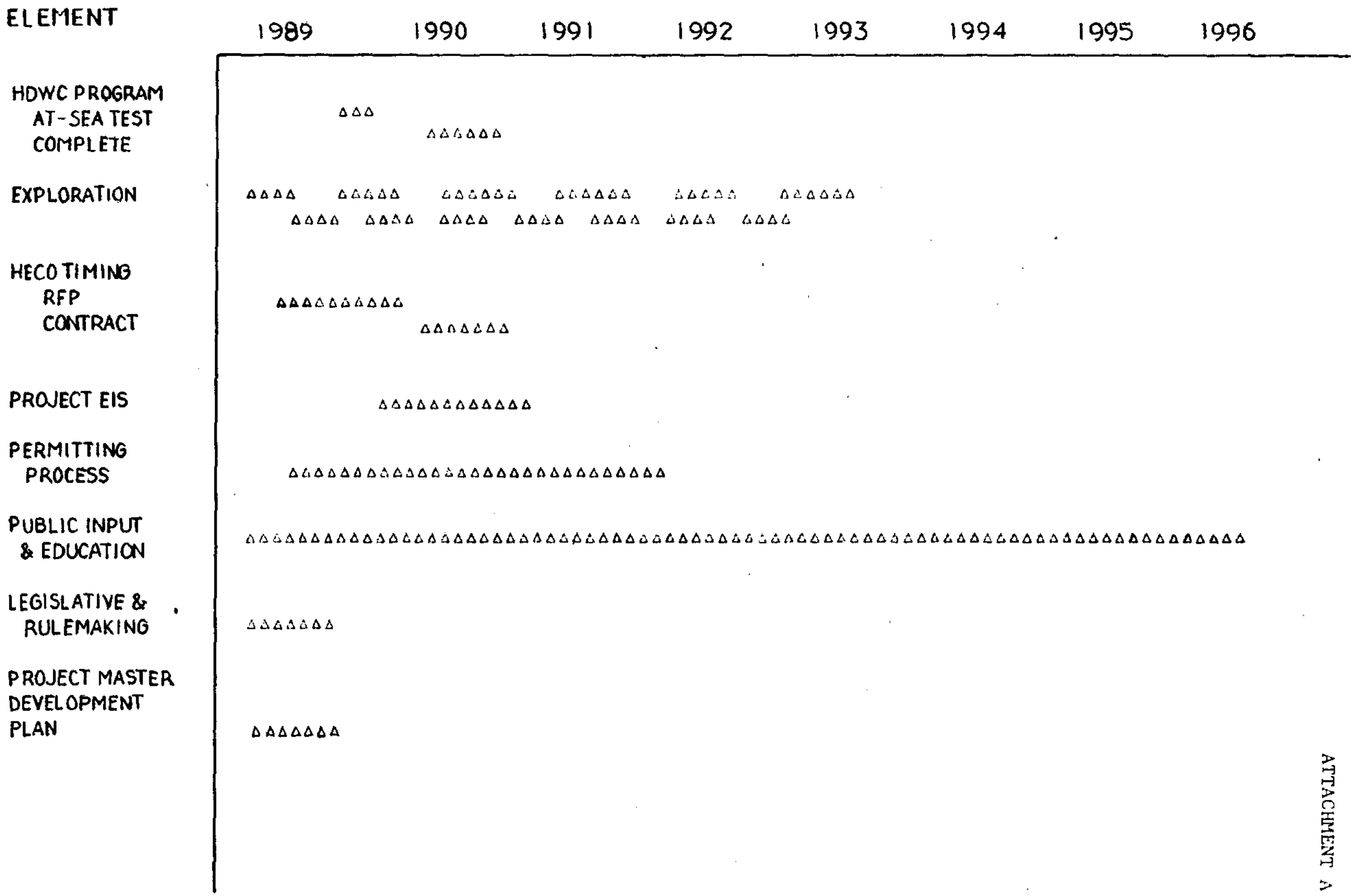
A. Project Timeline

B. Project Map

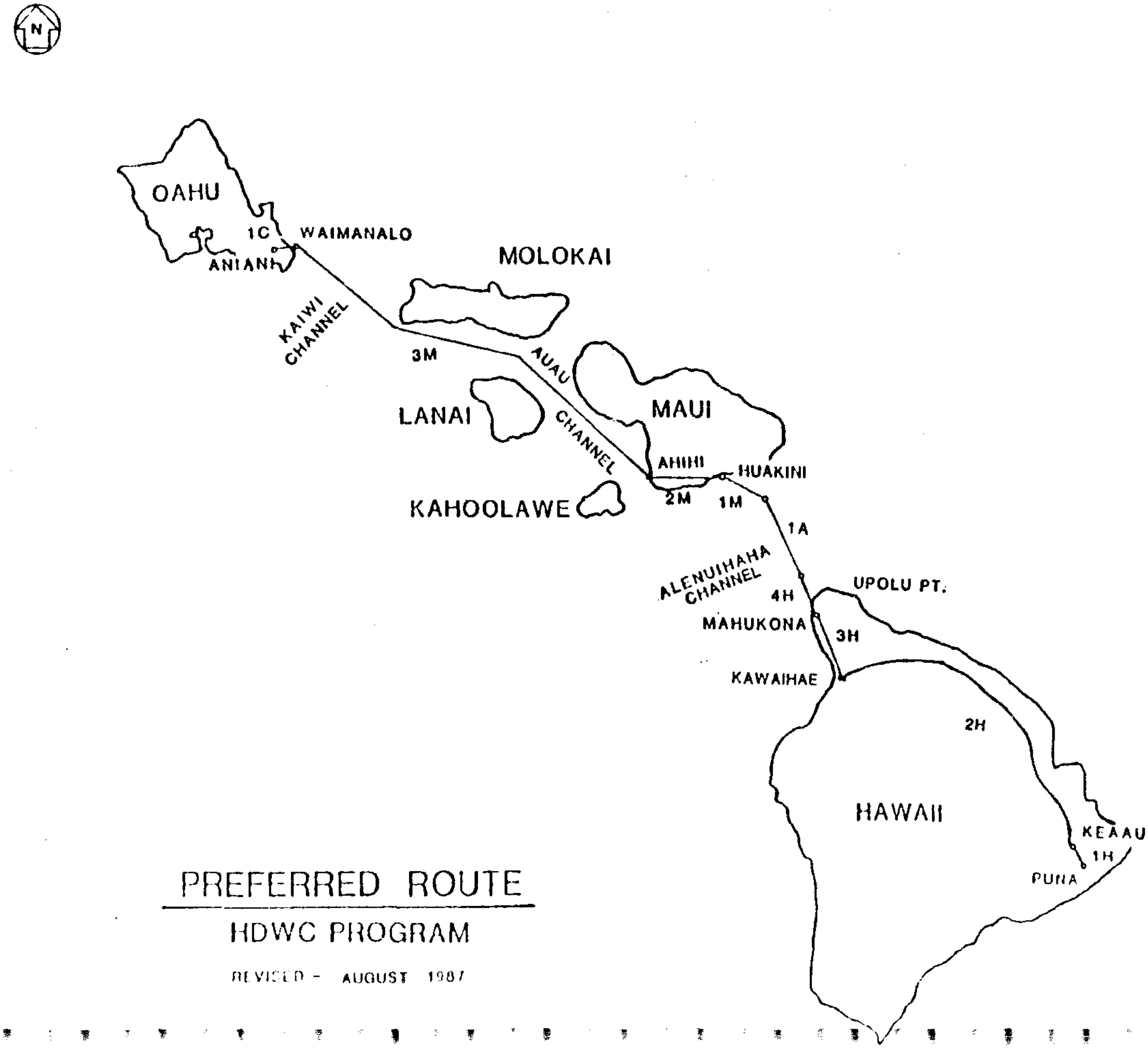
C. DBED List of Potential Permits

D. Notice of Intent to Respond

CABLE/GEOTHERMAL PROJECT



ATTACHMENT A



PREFERRED ROUTE

HDWC PROGRAM

REVISED - AUGUST 1987

ATTACHMENT B

ATTACHMENT C

GEOTHERMAL/CABLE PERMITTING REGIMES

	PERMIT ALWAYS REQUIRED	GOVT LEVEL	AGENCY	PROCESSING TIME (MONTHS) MIN	PROCESSING TIME (MONTHS) MAX	PUBLIC HEARING REQUIRED	CONTESTED CASE PROVISION APPLY	EIS
GEOTHERMAL								
GEOTHERMAL RESOURCE SUBZONE	Y	STATE	DLNR	6	12	Y	N	N
CONSERVATION DISTRICT USE PERMIT	Y	STATE	DLNR	6	6	Y	N	Y
GEOTHERMAL RESOURCE PERMIT	Y	COUNTY	PLNG	6	6	Y	N	Y
GEOTHERMAL MINING LEASE	Y	STATE	DLNR	7	12	?	?	N
GEOTHERMAL EXPLORATION PERMIT	Y	STATE	DLNR	2	2	N	N	N
GEOTHERMAL PLAN OF OPERATION	Y	STATE	DLNR	2	2	N	N	N
GEOTHERMAL WELL DRILLING PERMIT	Y	STATE	DLNR	2	2	N	N	N
AUTHORITY TO CONSTRUCT WELLS (AIR)	Y	STATE	DOH	3	6	?	?	N
PERMIT TO OPERATE WELLS (AIR)	Y	STATE	DOH	1	2	N	N	N
AUTHORITY TO CONST. POWER PLANT (AIR)	Y	STATE	DOH	3	6	?	?	N
PERMIT TO OPERATE POWER PLANT (AIR)	Y	STATE	DOH	1	2	N	N	N
UNDERGROUND INJECTION CONTROL	N	STATE	DOH	3	3	?	?	N
VARIANCE FROM POLLUTION (WATER)	N	STATE	DOH	3	3	?	?	N
PREVENTION OF SIGNIFICANT DETERIORATION	Y	FEDERAL	EPA	12	18	Y	N	N
BUILDING PERMITS	Y	COUNTY	PW	½	½	N	N	N
TRANSMISSION — INLAND — HAWAII								
PUBLIC UTILITIES COMMISSION APPROVAL	Y	STATE	PUC	—	—	Y	Y	N
CONSERVATION DISTRICT USE PERMIT	N	STATE	DLNR	6	6	Y	Y	?
NATURAL AREA RESERVE SYSTEM	N	STATE	DLNR	6	9	?	N	N
HISTORIC SITES	N	STATE	DLNR	—	12	?	N	N
EASEMENT FOR STATE PARKS, FORESTS	N	STATE	DLNR	—	11	N	N	N
BUILDING PERMITS	Y	COUNTY	PW	½	12	N	N	N
TRANSMISSION — COASTAL ZONE — HAWAII								
WASTAL ZONE CONSISTENCY	Y	STATE	DBED	1½	6	N	N	N
SPECIAL MANAGEMENT AREA PERMIT	Y	COUNTY	DLNG	4	?	Y	Y	Y
SHORELINE SETBACK VARIANCE	Y	COUNTY	DLNG	4	?	Y	Y	N
TRANSMISSION — OCEAN — STATEWIDE								
U.S. ARMY CORPS OF ENGR. PERMIT	Y	FEDERAL	ARMY	2	?	Y	—	?
NATIONAL ENVIRONMENTAL PROT. ACT EIS	N	FEDERAL	CEQ	6	?	?	—	Y
OCEAN WATERS CONSTRUCTION PERMIT	Y	STATE	DOT	2	3	?	?	N
NPDES	N	STATE	DOH	—	6	N	N	N
LEASE SUBMERGED LANDS	Y	STATE	DLNR	—	12	Y	N	N
TRANSMISSION — COASTAL ZONE — MAUI								
COASTAL ZONE CONSISTENCY	Y	STATE	DBED	1½	6	N	N	N
SPECIAL MANAGEMENT AREA PERMIT	Y	COUNTY	PLNG	4	?	Y	Y	Y
SHORELINE SETBACK VARIANCE	Y	COUNTY	PLNG	4	?	Y	Y	N
TRANSMISSION — INLAND — MAUI								
PUBLIC UTILITIES COMMISSION APPROVAL	Y	STATE	PUC	—	—	Y	Y	N
CONSERVATION DISTRICT USE PERMIT	N	STATE	DLNR	6	6	Y	Y	?
NATURAL AREA RESERVE SYSTEM	N	STATE	DLNR	6	9	?	N	N
HISTORIC SITES	N	STATE	DLNR	—	12	?	N	N
EASEMENT FOR STATE PARKS, FORESTS	N	STATE	DLNR	—	11	N	N	N
BUILDING PERMITS	Y	COUNTY	PW	½	12	N	N	N
TRANSMISSION — COASTAL ZONE — OAHU								
COASTAL ZONE CONSISTENCY	Y	STATE	DBED	1½	6	N	N	N
SPECIAL MANAGEMENT AREA PERMIT	Y	COUNTY	DLU	4	?	Y	Y	Y
SHORELINE SETBACK VARIANCE	Y	COUNTY	DLU	4	?	Y	Y	N
TRANSMISSION — INLAND — OAHU								
PUBLIC UTILITIES COMMISSION APPROVAL	Y	STATE	PUC	?	?	Y	Y	N
CONSERVATION DISTRICT USE PERMIT	N	STATE	DLNR	6	6	Y	Y	?
NATURAL AREA RESERVE SYSTEM	N	STATE	DLNR	6	9	?	N	N
HISTORIC SITES	N	STATE	DLNR	—	12	?	N	N
PUBLIC FACILITIES MAP AMENDMENT	Y	COUNTY	DGP	16	?	Y	?	N
BUILDING PERMITS	Y	COUNTY	BLDG	½	12	N	N	N
EASEMENT FOR STATE PARKS, FORESTS	N	STATE	DLNR	—	11	N	N	N

ATTACHMENT D

Director of Business and Economic Development
335 Merchant Street, Room 110
Honolulu, Hawaii 96813

Attention: Maurice H. Kaya, P.E.
Energy Program Administrator

NOTICE OF INTENT TO RESPOND

This is to inform you that:

ORGANIZATION'S NAME:

ADDRESS:

CONTACT PERSON:

TELEPHONE:

Intends to submit a proposal to perform master planning functions for the Proposed Geothermal/Inter-Island Cable Project, in accordance with the Request for Proposals dated March 10, 1989.

Name   Date

Title